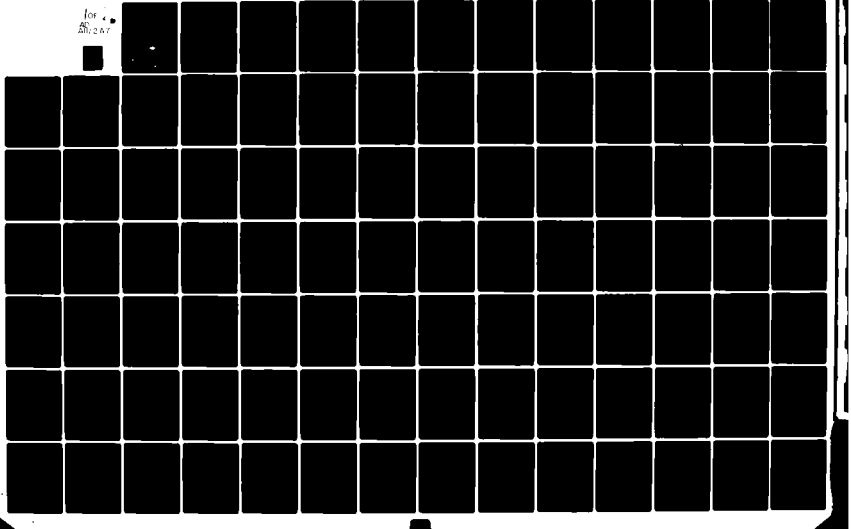
AD-A111 247 BOOZ-ALLEN AND HAMILTON INC BETHESDA MD F/G 15/5
GREAT LAKES/ST. LAWRENCE SEAWAY REGIONAL TRANSPORTATION STUDY: --ETC(U)
MAY 81 M R HORNE, A P FREE DACW35-80-C-0060
UNCLASSIFIED 719C-7 NL



(11)

ARCTEC, Incorporated

II

(11)

ARCTEC, Incorporated

Report 719C-7

DOCUMENTATION OF THE LOCK CAPACITY MODEL USED IN THE FEASIBILITY ANALYSIS OF GL/SLS CAPACITY EXPANSION. MEASURES TO THE YEAR 2050

TASK 10 Report of Great Lakes/St. Lawrence Seaway Regional Transportation Studies

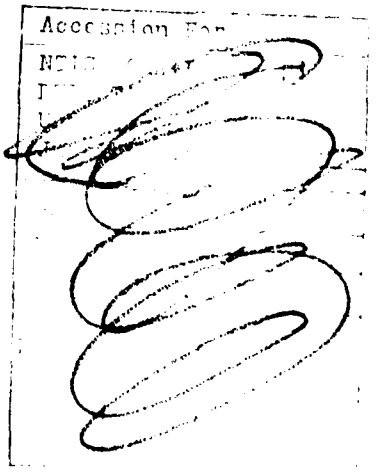
Prime Contract DACW 35-80-C0060

May 1981

M. R. Horne and A. P. Free

Submitted to

Department of the Army
North Central Division, Corps of Engineers
536 South Clark Street
Chicago, Illinois 60605



Submitted by

ARCTEC, Incorporated
9104 Red Branch Road
Columbia, Maryland 21045

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: 719C-7	2. GOVT ACCESSION NO. AD A111 297 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Great Lakes/St. Lawrence Seaway Regional Transportation Study: Documentation of the Lock Capacity Model Used in the Feasibility Analysis of GL/SLS Capacity Expansion Measures to the Year 2050.	5. TYPE OF REPORT & PERIOD COVERED: Final Report & Appendices
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): M.R. Horne and A.P. Free	8. CONTRACT OR GRANT NUMBER(s): DACW35-80-C0060
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Arctec Incorporated, 9104 Red Branch Road, Columbia, Maryland 21045	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Department of the Army, North Central Division, Corps of Engineers, 536 South Clark Street, Chicago, Illinois 60605	12. REPORT DATE: May 1981 13. NUMBER OF PAGES: 144
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office): U.S. Army Engineer District Buffalo, 1776 Niagara Street, Buffalo, N.Y. 14207	15. SECURITY CLASS. (of this report): Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

lock capacity model
queuing model
program listing
sample output listing
GL/SLS Lock capacity model

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report document the Great Lakes/St. Lawrence Seaway Lock Capacity Model. The report covers an overview, input data files, computer usage, program maintenance and the output module. The Appendices contain a listing of the program variables, a program listing, a data file listing and a sample output listing.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

1. OVERVIEW

1.1 Objectives

The specific objectives of this study were to develop a GL/SLS LOCK CAPACITY MODEL to be used as a planning tool to determine if, or when in time, the Soo, Welland, and St. Lawrence Lock Systems can be expected to reach capacity as a function of:

- Cargo Traffic Projections
- Vessel Fleet Projections
- Vessel Operating Characteristics and Locking Times
- Lock Operating Characteristics
- Length of Navigation Season
- Available Operating Time (Weather, Delays, Lock Malfunction Delays, Daylight-Only Navigation)
- Pleasure Craft and Non-Commercial Vessel Locking Requirements
- Winter Vessel and Lock Opening Procedures

Overall, the GL/SLS LOCK CAPACITY MODEL can be described as a queuing model which analyzes steady-state lock operatons and vessel-lock interaction. For a given set of the above-listed data and a specific year, the GL/SLS LOCK CAPACITY MODEL generates the following output for 14 separate time periods (10 months plus early and late April, and early and late December):

- Cargo Transported by Commodity and Direction
- Vessel Operating Fleet
- Yearly Vessel Transit Demand by Vessel Class, Commodity, and Direction
- Daily Vessel Transit Demand by Direction

- Lock Cycle Time by Direction (Mean and Standard Deviation)
- Average Vessel Waiting Time by Direction
- Average Vessel Queue Length by Direction
- Lock Utilization
- Vessel Delay Costs

1.2 Environment

The GL/SLS LOCK CAPACITY MODEL was developed for and submitted to the Department of the Army, North Central Division, Corps of Engineers by ARCTEC, Incorporated, the sole developer of the GL/SLS LOCK CAPACITY MODEL. The model is intended for use by the Corps of Engineers as a planning tool to determine when lock capacity is reached for the Soo, Welland, and St. Lawrence River lock systems and to analyze the influence of factors causing capacity. Production runs have been performed by ARCTEC, Incorporated for the Corps of Engineers to determine when the Soo, Welland, and St. Lawrence River lock systems reach capacity under existing conditions, and with the incorporation of several nonstructural and structural alternatives for improving system capacity.

The GL/SLS LOCK CAPACITY MODEL was run on a Boeing Computer Services (BCS) CDC mainframe computer under their EKS operating system. BCS maintains CDC Cyber 175 and CDC 6600 computers.

1.3 Program Specifications

The GL/SLS LOCK CAPACITY MODEL is able to handle multiple runs consisting of different combinations of lock system(s) and locking time range(s) in one job. It can also run combinations of such capacity expansion measures as changes in locking times, changes in draft, and changes in lock size.

The main program consists of a mainline program and 10 separate modules. The mainline program orders the execution of the 10 modules, which perform separate sections of the analysis. A conceptual flow diagram of the GL/SLS LOCK CAPACITY MODEL appears in Figure 1.1. Specifications for the GL/SLS LOCK CAPACITY MODEL, DATA FILES, and OUTPUT FILES are listed in Table 1.1.

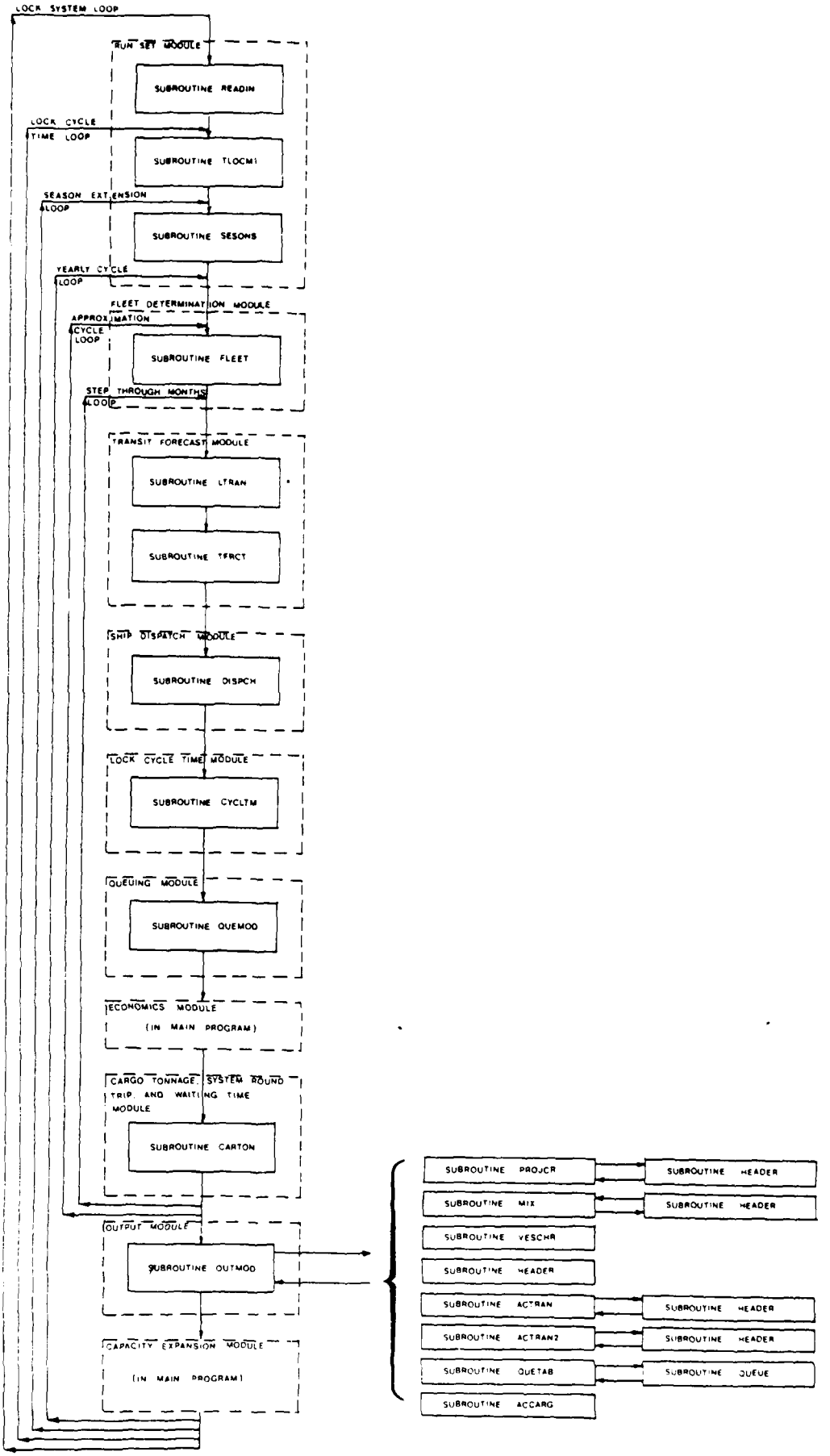


FIGURE 1.1 CONCEPTUAL FLOW OF THE GLASLS LOCK CAPACITY MODEL

TABLE 1.1

SPECIFICATIONS FOR THE GL/SLS LOCK CAPACITY MODEL, DATA FILES, AND OUTPUT

LOCK CAPACITY MODEL	
Language:	CDC Compatible FORTRAN
Core Required for one Run:*	160,000 Octal Words
Program Size:	
ASCII Listing	189 PRU's
Binary Compilation	217 PRU's
DATA FILES	
Size Per Lock System:	31 PRU's
OUTPUT FILE	
Size (Scenario No. 5, all 3 Lock Systems):	2718 PRU's
Print Size (same file as above):	21,129 Lines
BATCH SAMPLE RUN STATISTICS (SCENARIO NO. 5)	
Compilation Time	12 CP secs
Execution Time:	40 CP secs
Job Processing Computer Charge Units (CCU's):	439 (includes all three locks, execution only)
Cost per CCU (if run at low priority, P02)	$0.030 to 0.075

*One run consists of all three lock systems.

2. INPUT DATA FILES

2.1 Introduction

The GL/SLS LOCK CAPACITY MODEL consits of a main program and three (3) separate data files. This section on the input data files presents a list and detailed discussion of all the variables that appear in the input data files as well as a discussion of how certain variables may be manipulated to vary the results of the Lock Capacity Analyses.

Each Lock System is represented by its own data file. Each data file contains not only system, lock, and vessel data, but also contains run parameters. System, lock, and vessel data include operating conditions, route data, available operating time, locking times and locking characteristics, and vessel characteristics. Run parameters determine the lock system, maximum vessel class, locking time range(s), and season extension(s) to be analyzed. A complete list and description of all input variables can be found in Table 2.1 at the end of this section.

2.2 Run Parameters

The run parameters determine the lock system, locking time range(s), and season estension(s) that are used in the lock capacity analyses. The run condition data is contained in the first four lines in each data file, the first of which contains the go/no-go flag and the data file identifier. A data file is identified by a 1, 2, or 3 in the data file identifier column, representing the Soo, Welland, or St. Lawrence lock system, respectively. To run any particular lock system a 1 must appear as the go/no-go flag, as a 0 indicates that the lock system that the particular file represents is not to be analyzed. The same 1/0 designation is used to choose which season extension(s), and locking time variation(s) are to be used. The program, as modified for this study, is able to run only Season Extension 1 at the Soo Locks (April - December) and Season Extension 2, which denotes the same period (April - December) at the Welland Canal and the St. Lawrence River since variations in season extension were not selected by the Corps as capacity expansion alternatives.

The ability to implement a capacity expansion measure when capacity is reached is incorporated in the program. These measures are implemented by go/no-go flags, expansion measure identifiers, and the appropriate new data that deals with the expansion measure at the bottom of each data file.

2.3 System, Lock, and Vessel Data

System, lock, and vessel data includes data on operating conditions, available operating time, locking times, vessel characteristics, route data, and cargo shipping demand. Data pertaining to the validation of the base year is also included in the input data, such as the transit distribution factors, which determine the percentage of total annual loaded transits that occur in each of the operating periods. A complete description of each variable can be found in Table 2.1 on the following pages.

TABLE 2.1

INPUT DATA (IN ORDER OF OCCURRENCE)

GONOGO	Go/no-go flag (See Section 3.1)
IS	Data file identifier (See Section 3.1)
LU	Maximum vessel class
ISES(4)	Season extension identifier (See Section 3.1)
ILTM(3)	Locking time range identifiers (See Section 3.1)
ZBHF(12)	Ship utilization factors
FACTOR	Cargo Multiplier: Can be used to vary the total cargo potential for sensitivity analyses
CALFAC	System queue length and waiting time multiplier: CALFAC accounts for the number of non-constraining locks in the Welland Canal and the St. Lawrence River.
SYSFAC	System lock cycle time multiplier: SYSFAC accounts for the number of non-constraining locks in the Welland Canal and the St. Lawrence River.
SYSADD	Time spent in the flight locks - hours
SYSTIM	Round trip time in the Welland Canal and the St. Lawrence River minus time spent in the locks and lock queues - hours
ADDPCT(6,12)	Fleet mix ship building percentages as a function of commodity and vessel class
CC(12,6)	Carrying capacities as a function of vessel class and commodity - short tons
TDF(12,14)	Transit distribution factors: TDF represents the percentage of annual loaded transits occurring in each of the 14 operating periods for the base year validation. TDF is a function of vessel class and operating period. These are only used for validation.
WHEAT(80,3)	Cargo Projections for wheat: WHEAT is a function of year and direction (upbound, downbound, or total)
STLPRD(80,3)	Same as above for steel products
GENCAR(80,3)	Same as above for general cargo
SOY(80,3)	Same as above for soybeans
BLYRYE(80,3)	Same as above for barley and rye

TABLE 2.1 (CONTINUED)

CORN(80,3)	Same as above for corn
OILSD(80,3)	Same as above for oilseeds
ALMSTN(80,3)	Same as above for limestone
AIRORE(80,3)	Same as above for iron ore
RAWMAT(80,3)	Same as above for raw materials
COAL(80,3)	Same as above for coal
PETROL(80,3)	Same as above for petroleum products
CEMENT(80,3)	Same as above for cement
AMIN(80,3)	Same as above for nonmetalic minerals
DRYBLK(80,3)	Same as above for dry bulk
DATM(14)	Operating hours per day for each operating period. DATM is a function of operating period.
TMLOCK(12,2,4)	Normal range of locking times in minutes: TMLOCK is a function of vessel class, direction, and lock.
TLTML2(12,2,4)	Low range of locking times
TLTML3(12,2,4)	High range of locking times
STDEV(12,2,4)	Locking time standard deviation in minutes: STDEV is a function of vessel class, direction and lock.
BTF4	Base year bias traffic factor for early April: If BTF4 = 1.0, maximum bias is obtained; if BTF4 = 0.0, zero bias is obtained.
BTF5	Base year bias traffic factor for late April
BTF13	Base year bias traffic factor for early December
BTF14	Base year bias traffic factor for late December
TURNBK(2)	Turnback time in minutes: TURNBK is a function of lock
XSHIP(12)	Vessel operating costs in $/hr: XSHIP is a function of vessel class
XCAP(12)	Vessel capital costs in $/hr: XCAP is a function of vessel class
PCRF(14,2)	Pleasure craft and ice lockages in lockages per day: PCRF is a function of operating period and direction.
FLOAD(6)	Loading factor: FLOAD accounts for broken stowage space in the cargo vessels. FLOAD is a function of commodity.
DISTN(2,6)	Mean one-way distances in miles: DISTN is a function of direction and commodity.

TABLE 2.1 (CONTINUED)

FILL(6,12)	Loading rate in short tons per hour: FILL is a function of commodity and vessel class.
EMPTY(6,12)	Unloading rate in short tons per hour: EMPTY is a function of commodity and vessel class.
HRS(14,4,6)	Available operating hours per operating period: HRS is a function of operating period, season extension, and commodity. Cargo will be transported in any operating period with a non-zero entry for HRS.
VSA(14,12,4)	Vessel speed of advance in miles per hour: VSA is a function of operating period, vessel class, and season extension. Vessel classes can be prohibited from operating in certain operating periods (winter periods) by setting VSA for that particular class and operating period to zero (this has and can be done in the program also (See Section 5.4.1)).
DIN(14,4)	Relative demand indexes: DIN represents the relative demand for cargo to be shipped during each operating period and so influences the tonnage distribution over the year. DIN accounts for the start-up and slow-down at the beginning and end of operating season and was chosen to duplicate the start-up and slow-down observed in the base year. DIN may be any number from 00.0 to 99.9 and is a function of operating period and season extension.
PO(80,12)	Vessel phase-out fractions: PO accounts for old vessel phase-out and represents the percentage of vessels phased out of each class for each year. PO is a function of year and vessel class.
BASEFT(6,12)	Zero-backhaul base year fleet: BASEFT was arrived at through validation and is a function of commodity and vessel class.
BTF(14,4)	Biased traffic factors for non-base year analyses. If BTF = 1.0, maximum bias results; if BTF = 0.0, minimum bias results (See Section 4.4). BTF is a function of operating period and season extension.
TDFCX(5,4)	Transit distribution factors for extended season grain and general cargo: Because extended season grain and general cargo are distributed evenly over the extended season, the transit distribution factors must be specified. Note that TDFCX sums to one for both commodities in order to transport exactly the extended season tonnage potential. TDFCX is a function of season extension periods and season extension.
CAPINC(12)	Capacity increase with increases in system draft: CAPINC is a function of ship class and is tabulated in short tons per year.

TABLE 2.1 (CONTINUED)

ICAPX	Go/no-go flag: ICAPX determines whether to implement a capacity expansion measure or not (1 = yes, 0 = no)
MEASUR	Capacity expansion measure identifier: 1 - Locking time and reductions 2 - Construct larger locks 3 - Increase allowable ship draft
FOR MEASUR = 1	
REDLT(3,2,5)	Locking time reduction factors: REDLT is a function of lock system (Soo, Welland, St. Lawrence), direction, and alternative.
NHOWTO	Alternative identifier
FOR MEASUR = 2	
NEWLU	New maximum vessel class
ZBHF(12)	Same as previous ZBHF, but for additional vessel classes.
ADDPCT(6,12)	Same as previous ADDPCT but for additional vessel classes
CC(12,6)	Same as previous CC but for additional vessel classes
TMLOCK(12,2,4)	Same as previous TMLOCK but for additional vessel classes
TLTML2(12,2,4)	Same as previous TLTML2 but for additional vessel classes
TLTML3(12,2,4)	Same as previous TLTML3 but for additional vessel classes
STDEV(12,2,4)	Same as previous STDEV but for additional vessel classes
FILL(6,12)	Same as previous FILL but for additional vessel classes
EMPTY(6,12)	Same as previous EMPTY but for additional vessel classes
VSA(14,12,4)	Same as previous VSA but for additional vessel classes
PO(80,12)	Same as previous PO but for additional vessel classes
CAPINC(12)	Same as previous CAPINC but for additional vessel classes
FOR MEASUR = 3	
DRAFT	New allowable ship draft through the system
LOCKS	Go/no-go flag that allows implementation of new locks along with deeper draft. (0 = no, 1 = yes)

3. COMPUTER USAGE

3.1 Selecting the Run Parameters

The run parameters determine which system(s), maximum vessel class(es), season extension(s), and locking time range(s) are analyzed. These run parameters appear in the first four lines of each data file as shown in Figure 3.1.

3.2 Running the GL/SLS LOCK CAPACITY MODEL

Experience with the GL/SLS LOCK CAPACITY MODEL has shown that the most efficient method of using the program is to keep the program and data files stored in separate indirect access files and to run the program from the terminal in the remote batch mode. To run the program in the remote batch mode the user must use a submit file to submit a desired job. The sample submit file in Figure 3.2 was used to submit the previously compiled program.

3.3 Output

Results are printed as nine tables in the following order:

Projected Cargo Tonnage
Fleet Mix
Vessel Characteristics
Yearly Transits
Daily Transit Demand
Actual Transits
Queuing Information
Delay Cost
Actual Cargo Flow

Data is printed out as a function of operating period, commodity, vessel class and direction through the locks. For purposes of this project the delay cost output has been suppressed. A sample copy of one year of one run appears in Appendix D.

FIGURE 3.1

SAMPLE RUN PARAMETERS

1,3	GONOGO, Data File Identifier
7	Maximum Vessel Class
0,1,0,0	Season Extensions
1,0,0	Locking Times (Normal, Low, High)

- The go/no-go flag should be 1 for a data file if that particular system is to be analyzed, and 0 if not.
- The Data File Identifier should be left constant; 1 signifies the Soo system, 2 the Welland Canal, and 3 the St. Lawrence River.
- Vessel Class is for baseline only. New vessel classes are input with expansion measure data.
- The four figures in the line labeled "Season Extensions" represent from left to right, season extension 1, 2, 3, and 4. A 1 in the appropriate space denotes that the season extension is to be analyzed while a 0 denotes that it is not. Note that the program is now only capable of running April thru December which corresponds to season extension 1 at the Soo and season extension 2 at the Welland and St. Lawrence River. This is due to the fact that the expansion alternatives selected by the Corps did not include season extension. The program was therefore modified and streamlined in that area.
- The three figures on the line labeled "Locking Times" represent, from left to right, normal, low, and high locking time ranges. Again, the same run/no-run convention applies.

FIGURE 3.2 SAMPLE SUBMIT FILE

```
ANALOK,CM20600,T200.
USER,CEF218,ARCTEC.
GET,TAPE1=NWS00.
GET,TAPE2=NWWEL.
GET,TAPE3=NWSLS.
GET,TAPE3=NWSLS.
BREVIS.
EXIT,U.
REWIND,OUTPUT.
COPYCF,OUTPUT,BUGS.
REPLACE,BUGS.
REWIND,TAPE8.
COPYCF,TAPE8,TABLES.
REPLACE,TABLES.
REWIND,TAPE9
COPYCF,TAPE9,DBGOUT.
REPLACE,DBGOUT.
COST.
DAYFILE,ERROR.
REPLACE,ERROR.
```

FIGURE 3.2 SAMPLE SUBMIT FILE (CONTINUED)

LINE	
1	User, Memory Limit, Time Limit
2	ID#, Password
3	Get a copy of the LOCK CAPACITY MODEL (Compiled Version) from the files
4	Get a copy of the Soo data file
5	Get a copy of the Welland data file
6	Get a copy of the St. Lawrence data file
7	Execute the program
8	If there are execution errors, this allows the rest of the submit file to be executed.
9-11	Rewinds and copies the load map to the file BUGS and stores it as an indirect access permanent file
12-14	Rewinds and copies the output to file TABLES and stores it as an indirect access permanent file
15-17	Rewinds and copies a debugging file produced by WRITE statements in the program to a file DBGOUT and stores it as an indirect access permanent file
18	Gives the total cost of the job
19-20	Copies the dayfile (which is a record of the statistics of the run) on the file ERROR and stores it as an indirect access permanent file.

Once the submit file has been created the job can be submitted with the commands:

```
GET,submitfilename
SUBMIT,submitfilename,NL
```

4. PROGRAM MAINTENANCE

The GL/SLS LOCK CAPACITY MODEL consists of a mainline program which is divided into ten (10) separate modules, and three (3) separate data files. This section on program maintenance presents detailed descriptions of the mainline program and the individual modules. A detailed discussion of the data files can be found in Section 2.

4.1 Mainline Program

The purpose of the mainline program is to receive the data files, establish the common blocks, dimension variables not in the common blocks, to initialize certain variables through the use of data statements, to order the execution of the modules, and to control the execution of the GL/SLS LOCK CAPACITY MODEL. As the program listing (Appendix B) indicates, the mainline program begins by defining tape numbers which correspond to the data files and output files as follows:

TAPE 1 - SOO DATA FILE

TAPE 2 - WELLAND DATA FILE

TAPE 3 - SLP DATA FILE

TAPE 8 - OUTPUT FILE

TAPE 9 - DEBUG FILE FOR INTERNAL DEBUGGING WRITE STATEMENTS

HELP - DEBUG FILE FOR CDC SUPPORTED DEBUG SOFTWARE OUTPUT

The program header is followed by the common definitions, the dimension statements, and the data statements. A list and brief description of the common blocks can be found in Appendix A. A list and brief description of the data statements can be found in Table 4.1.

Following the data statements, the program reads the go/no-go flag in the first lock system data file to determine if an analysis of that lock system is to be run. Once a lock system has been selected the first module begins execution. The ten (10) Modules are listed below.

TABLE 4.1 VARIABLES IN DATA STATEMENTS

ABTEST	Any number close to zero (for logical comparisons)
DM(14)	Days per period (14 periods per year)
IBMO(14)	Hollerith constants containing the names of the 14 periods
LMAX(12)	Maximum length of vessels
LMIN(12)	Minimum length of vessels
MONRAY(14)	Contains, in sequence, the periods to be analyzed (eg: MONRAY(1) signifies early April, which is the first period to be analyzed)
NEXPG	Carriage control to begin each table on a new page
RHOMAX	Maximum lock utilization allowed for all locks except for the Poe Lock
RHOPOE	Maximum lock utilization allowed for the Poe Lock
TIMES(14)	Increase in locking time for each period (mainly for winter months)
TLOCKM	Typical locking time for the MacArthur Lock
TTI	Transit time increase factor which is a function of the month and increases transit times due to winter conditions

1. Run Set Module - The Run Set Module reads the appropriate data file, determines the conditions under which the model is to be run (season extension, locking time variation) assigns values to working variables in accordance with the specified conditions, and initiates the major do-loops that order the run.

2. Fleet Determination Module - The Fleet Determination Module determines the required zero - backhaul fleet.

3. Transit Forecast Module - The Transit Forecast Module determines the number of loaded and ballast transits, pleasure craft lockages, and ice lockages that occur in each operating period and converts the zero backhaul fleet to the real fleet.

4. Ship Dispatch Module (Soo System Only) - The Ship Dispatch Module dispatches ships to the separate Soo Locks on the basis of equal lock utilization or equal waiting time.

5. Lock Cycle Time Module - The Lock Cycle Time Module determines the mean lock cycle time for a particular lock and fleet mix.

6. Lock Queueing Module - The Lock Queuing Module determines the length of the incoming queue and the waiting time for a particular lock and fleet mix.

7. Economic Module - The Economic Module converts the average waiting time into the delay cost for each lock and vessel.

8. Cargo Tonnage Module, System Round-Trip and Waiting Time Module - This module computes the projected cargo flow and the actual cargo flow for each period and commodity. It also calculates the time it takes for a vessel to make one round-trip in the Welland Canal and the St. Lawrence River including time spent in queues and slowdowns due to weather conditions.

9. Output Module - The Output Module assembles the data generated by the other modules, assigns the data to working variables for printout purposes, and produces the output file.

10. Capacity Expansion Module - After the system reaches capacity this module reads in new data and initializes the appropriate variables for the particular capacity expansion measure that is to be analyzed. The module then returns control back to the beginning of the yearly loop and resumes execution until capacity is reached again, whereupon a new measure can be implemented. The program also has the option to halt whenever the system reaches capacity.

4.2 The Run Set Module

The purpose of the Run Set Module is to read the appropriate data file, determine the conditions under which the model is to be run, assign values to working variables in accordance with the specified conditions, and inititate the major do-loops that order the run. The first step in the Run Set Module is to CALL READIN, which reads in the system data and run data. Once the locking time variation(s), season extension(s), and maximum ship class are known, the locking times are set in subroutine TLOCMT and the cargo projections are set in subroutine SESONS.

Input and output data are identical due to the fact that the Run Set Module is basically a data input model. Table 2.1 contains input/output through the data files.

4.2.1 Subroutine READIN

The purpose of subroutine READIN is to read in data from the appropriate data file and to initialize necessary working variables to this data. Run specification variables are read in first, followed by system, vessel, and lock data. Following the data read-in, the carrying capacities are modified and assigned to working variables, and the transit modified and assigned to working variables, and the transit distribution factors for the base year are also assigned to working variables. Also the 15 input commodity projections are collapsed into 6 working commodities; ore, coal, stone, grain, other bulk, and general cargo.

The carrying capacity modification allows fine tuning of the carrying capacities during validation and the same mechanism can be used for sensitivity analyses. Because only three carrying capacities are read in for each ship (and there are 6 commodities) the carrying capacities are assigned under the rule that:

$$CC_{\text{ore}} = CC_{\text{stone}}$$

$$CC_{\text{coal}} = CC_{\text{grain}}$$

$$CC_{\substack{\text{other}\\\text{bulk}}} = CC_{\substack{\text{general}\\\text{cargo}}}$$

The transit distribution factors for the base year validation represent the percentage of annual transits occurring for any period for each ship class. Because there are only three values of TDF read in per period (there are up to 11 classes) TDF is assigned under the following rule:

Soo System

$TDF_4 = TDF_5$

$TDF_6 = TDF_7 = TDF_8 = TDF_9$

$TDF_{10} = TDF_{11}$

Subrscripts denote vessel class

Welland and St. Lawrence River

$TDF_4 = TDF_6$

$TDF_5 = TDF_7$

Note: For the Welland and St. Lawrence, class 6 denotes oceans; class 5 denotes class 5 and 6 lakers

Because subroutine READIN only reads in data, input data and output data are identical. Input/output data for subroutine READIN is listed in Table 4.2.

4.2.2 Subroutine TLOCMT

The purpose of subroutine TLOCMT is to assign low or high locking times to the locking time working variable. The working variable has been previously initialized to the normal locking time values in subroutine READIN. Input/output data is listed in Table 4.3.

4.2.3 Subroutine SESONS

The purpose of subroutine SESONS is to assign the correct season extension cargo potential to the working variable for cargo potential. Input/output data is listed in Table 4.4.

4.3 The Fleet Determination Module

The purpose of the Fleet Determination Module is to determine the zero - backhaul fleet required to carry the specified cargo given the system and vessel characteristics. The entire Fleet Determination Module is contained within subroutine FLEET.

TABLE 4.2 INPUT AND OUTPUT: SUBROUTINE READIN

INPUT

Through the Argument List

IS	Lock System identifier
ISYST	Iteration variable for lock system
KU	Number of different locks
IDEBUG	Logical variable for debug output

OUTPUT

Through the Argument List

LU	Maximum vessel class
FACTOR	Cargo multiplier
BTF4	Bias traffic factor for validation - early April
BTF5	Bias traffic factor for validation - late April
BTF13	Bias traffic factor for validation - early December
BTF14	Bias traffic factor for validation - late December
CALFAC	System Waiting Time Multiplier (Number of non-constraining locks)
CARF	Fraction of the major commodity groups (6) that each of the input commodities (15) represent
SYSADD	Time spent in flight locks
SYSFAC	System Lock Cycle Time Multiplier (number of non-constraining locks)
SYSTIM	System round-trip time minus time spent in locks and queues
TDFCX(5,4)	Transit distribution fractions for extended season grain and general cargo

Through Common CALCOM

EXTPT(6,2,80)	Extended season cargo potential - grain and general cargo
HRS(14,4,6)	Operating hours

TABLE 4.2 (Continued)

TMLOCK(12,2,4)	Normal locking time
VSA(14,12,4)	Vessel speeds of advance

Through Common MINARY

BASEFT(6,12)	Base year fleet
CC(6,12)	Carrying capacities
DISTN(2,6)	Distance
EMPTY(6,12)	Unloading rate
FILL(6,12)	Loading rate
FLOAD(6)	Loading factor
PO(80,12)	Phase out fractions
TDF(12,14)	Transit distribution factors - validation
ZBHF(12)	Ship utilization factor
ADDPCT(6,12)	Fleet mix ship building percentages

Through Common PRELIM

ISES(4)	Season extension indicator
ILTM(3)	Locking time indicator

Through Common DAT1

BTF(14,4)	Bias traffic factors
CAREX1(6,2,80)	Season extension 1 cargo potential
DATM(14)	Operating hours per day per period
DIN(14,4)	Demand indexes
IZBH(12)	Ship utilization factors
PCRF(14,2)	Pleasure craft and ice lockages
LYEAR(80)	Year identifier
STDEV(12,2,4)	Standard deviation
TLTML2(12,2,4)	Low locking time
TLTML3(12,2,4)	High locking time
TURNBK(4)	Turnback time

TABLE 4.2 (Continued)

XCAP(12)	Ship capital cost
XSHIP(12)	Ship operating cost
ZB(12)	Ship utilization factor

Note: For a more detailed variable description, see Appendix A.

TABLE 4.3 INPUT AND OUTPUT: SUBROUTINE TLOCMT

INPUT

Through the Argument List

LU	Maximum vessel class
IS	Lock system identifier
TLTML(12,2,2)	Locking time variable that is either TLTML2 or TLTML3

Through Common CALCOM

TMLOCK(12,2,2)	Locking time working variable

OUTPUT

Through Common CALCOM

TMLOCK(12,2,2)	Locking time working variable

Note: For a more detailed variable description, see Appendix A.

TABLE 4.4 INPUT AND OUTPUT: SUBROUTINE SESONS

INPUT

Through the Argument List

ISN	Loop index for season extensions
FACTOR	Cargo tonnage multiplier
CAREX(6,2,80)	Cargo tonnage potential input label; is equal to CAREX1 for season extension 1 and CAREX2 for season extension 2
DIN(14,4)	Demand indexes per operating period and season extension

OUTPUT

Through Common CALCOM

CARGOP(6,2,80)	Cargo potential working variable
TDIN	Total of the input demand indexes

4.3.1 Subroutine FLEET

Subroutine FLEET calculates the new fleet in 3 steps.

1. Establish the number of round-trips one ship can make in one year.
2. Update the base year fleet and calculate the annual transport capacity for the remaining fleet.
3. Add or delete ships until cargo potential = transport capacity.

Expanded, the steps are performed as follows:

Step 1. Calculate the number of round-trips one ship can make in one year.

$$\text{Round Trips Per Year} = TRIPYR_{i,j} = HRSYR_i / TRIPTM_{i,j}$$

for Commodity i and Vessel Class j,

where $\sum^{K}$ sums over the periods in one year

$$\text{Operating Hours Per Year} = HRSYR_i = \sum^{K} HRS_{i,K}$$

$$\text{Time Per Round-Trip} = TRIPTM_{i,j} = DF \times \left(2 \times \frac{WDIST_i}{VSM_{i,j}} + \frac{CC_{i,j}}{EMPTY_{i,j}} \frac{FLOAD_i}{} + \frac{CC_{i,j} \times FLOAD_i}{FILL_{i,j}}\right) + TIMELK_j$$

$$\text{Mean Vessel Speed} = VSM_{i,j} = \frac{\sum^{K} VSA_{i,j,K} \times HRS_{i,k}}{HRSYR_i}$$

$VSA_{i,j,K}$ = Vessel speed of advance

$HRS_{i,j}$ = Operating hours per period

$CC_{i,j}$ = Carrying capacity

$FILL_{i,j}$ = Loading rate

$EMPTY_{i,j}$ = Unloading rate

$WDIST_i$ = Round-trip distance

$TIMELK_j$ = Time spent in locks

$FLOAD_j$ = Loading factor

Step 2. Update the base year fleet and calculate the annual transport capacity for the remaining fleet.

$$\text{Remaining Fleet} = FLEETR_{i,j} = BASEFT_{i,j} \times (1 - PO_{j,K})$$

$$\text{Transport Capacity By Class} = SHPCAP_{i,j} = FLEETR_{i,j} \times CC_{i,j} \times TRIPYR_{i,j} \times FLOAD_j$$

$$\text{Annual Transport Capacity} = ANCAP_i = \sum^{j} SHPCAP_{i,j}$$

for Commodity i and Year K

where $\sum^{j}$ sums over the vessel classes

$PO_{i,K}$ = Phase out fractions

$BASEFT_{i,j}$ = Base year fleet

Step 3. Add or delete ships until cargo potential = transport capacity

$$\text{Cargo Surplus (or Deficit)} = CARGON_i = CARGOP_{i,K,\text{up}} + CARGOP_{i,K,\text{dn}} - ANCAP_i$$

for Commodity i, Vessel Class j, and Year K

where $CARGOP$ = Cargo potential

For surplus cargo, ships are added to the fleet by building percentages according to ship class.

First determine what composite ship (in tons of capacity by commodity) is to be added:

$$\text{Composite Ship to be Added} = COMSHA_i = \sum^{j} (ADDPCT_{i,j} \times TRIPYR_{i,j} \times CC_{i,j} \times FLOAD_i)$$

where $ADDPCT_{i,j}$ = fleet mix ship building percentage.

Then determine the number of ships to be added and calculate the new fleet.

$$\text{No. of Ships to be Added} = ADDSHP_{i,j} = \frac{CARGON_i}{COMSHA_i} \times ADDPCT_{i,j}$$

$$\text{New fleet} = FLEETN_{i,j} = FLEETR_{i,j} + ADDSHP_{i,j}$$

If $CARGON_i < 0$ delete ships starting with the smallest until $CARGON = 0$.

- Number of Deleted Ships $= DELSHP_{i,j} = \frac{-CARGON_{i,j}}{CC_{i,j} \times TRIPYR_{i,j} \times FLOAD_i}$

- If $DELSHP_{i,j} \geq FLEETR_{i,j}$, $DELSHP_{i,j} = FLEETR_{i,j}$

- Recalculate $CARGON_i$

  $CARGON_i = CARGON_i + DELSHP_{i,j} \times CC_{i,j} \times TRIPYR_{i,j} \times FLOAD_i$

- Repeat with next larger ship class until $CARGON=0$.

- Subtract $DELSHP_{i,j}$ from $FLEETR_{i,j}$ to get the new fleet, $FLEETN_{i,j}$.

During the process of adding ships, Class 6 vessels are not added for ore, coal, stone, or grain in the Welland and St. Lawrence because for these systems a Class 6 vessel denotes an ocean vessel.

At this point it is appropriate to point out that the new fleet is a zero-backhaul fleet and to illustrate how the approximation loop is used to get an accurate actual fleet. This is done in subroutine TFRCT.

The Real Fleet = $SHIP_{i,j}$ = $FLEETN_{i,j}$ x $REDFT_j$

for Commodity i and Vessel Class j

where $REDFT_i$ is:

$$REDFT_j = .5 + \frac{GBAL_j}{GBAL_j + GLOAD_j}$$

where

$GBAL_j$ = Yearly total ballast transits of class j vessels

$GLOAD_j$ = Yearly total loaded transits of class j vessels

The resulting change in the fleet mix may cause a change in the capacity analysis. To correct this, the correct fleet is determined in 3 iterations by the IAPPROX loop. Input/Output data for subroutine FLEET is listed in Table 4.5.

4.4 The Transit Forecast Module

The purpose of the Transit Forecast Module is to determine the number of loaded transits, ballasted transits, pleasure craft lockages, and ice lockages that occur for each of the 14 periods. The Transit Forecast Module accomplishes this in four steps.

1. Loaded transits are calculated in subroutine LTRAN
2. Ballast transits are calculated on the basis of ship utilization (input)
3. Bias traffic is assigned according to the bias traffic parameters (input)
4. Pleasure craft and ice lockages are included in the transit demand (input)

The four steps above are performed for each of the 14 operating periods as dictated by a loop on operating periods at the beginning of the module. Steps 2, 3, and 4 are performed in subroutine TFRCT. Input/Output data for subroutine TFRCT is listed in Table 4.6.

TABLE 4.5 INPUT AND OUTPUT: SUBROUTINE FLEET

INPUT

Through the Argument List

INDEXC	IAPPROX -1
IR	Year indicator
ISN	Season extension indicator
IS	Lock system indicator
LU	Maximum ship class

Through Common MINARY

BASEFT(6,12)	Base year fleet
CC(6,12)	Carrying capacity
DISTN(2,6)	Distance
EMPTY(6,12)	Unloading rate
FILL(6,12)	Loading rate
FLOAD(6)	Loading factor
PO(80,12)	Phase out fractions
REDFT(12)	Fleet reduction factor

Through Common CALCOM

CARGOP(6,2,80)	Cargo projections
HRS(14,4,6)	Operating hours per period
VSA(14,12,4)	Vessel speed of advance

OUTPUT

Through Common MINARY

FLEETN(6,12)	New fleet
HRSYR(6)	Operating hours per year
VSM(12,6)	Mean vessel speed per year

TABLE 4.6 INPUT AND OUTPUT: SUBROUTINE TFRCT

INPUT

BTF4	Bias traffic factor for validation - early April
BTF5	Bias traffic factor for validation - late April
BTF13	Bias traffic factor for validation - early December
BTF14	Bias traffic factor for validation - late December
BTF(14,4)	Non-validation bais traffic factors
CARGOP(6,2,80)	Cargo potential for normal fleet
DM(14)	Days per operating period
EXTPT(6,2,80)	Cargo potenital for extended season grain and general cargo
PCRF(14)	Pleasure craft and ice lockages per period
ZBHF(12)	Ship utilization factor

OUTPUT

DLTRN(12,3,14)	Daily loaded transits per period
DBTRN(12,3,14)	Daily ballast transits per period (also includes pleasure craft and ice lockages)

Before the Transit Forecast Module calls subroutine LTRAN the periods are sequenced in order of execution by the array MONRAY(14), and the demand indexes (DIN) are converted into absolute demand factors that when totaled over the periods for one year sum to 1.0 (DFA). At this point subroutine LTRAN is called. Subroutine LTRAN calculates the cargo transits per period:

$$\text{Cargo Transits Per Period} = CTRNPM_{i,j}$$

which are converted into average daily loaded transits:

$$DLTRN_{i,K} = \frac{\sum_{i} CTRNPM_{i,j}}{DM_K}$$

for Commodity i and Vessel Class j

where $\sum_{i}$ sums over all commodities

and DM_K is the days per operating period for operating period K.

Actual ballast transits range from the maximum of one ballast transit for every loaded transit to the minimum possible ballast transits (loaded transits up - loaded transits down). Exactly where in this range the number of ballast transits actually lie is determined by the ship utilization factor factor ZBHF (previously named the zero-backhaul factor).

When ZBHF = 1.0 there is total ship utilization (minimum ballast transits)

When ZBHF = 0.0 there is no ship utilization (maximum ballast transits)

Example : calculate ballast transits down

$$EMPTY = (DLTRN_{j,K})_{\text{down}} - (DLTRN_{j,K})_{\text{up}}$$

If $EMPTY > 0$

$$(DBTRN_{j,K})_{\text{dn}} = [(DLTRN_{j,K})_{\text{up}} + EMPTY] \times (1 - ZBHF_j)$$

If $EMPTY < 0$

$$(DBTRN_{j,K})_{\text{dn}} = [(DLTRN_{j,K})_{\text{down}} + EMPTY] \times (1 - ZBHF_j)$$

The amount of bias traffic is determined by the bias traffic factors, where:

BTF = 1.0 causes maximum bias

BTF = 0.0 causes no bias

Bias traffic is generated by manipulating the ballast transits for the desired operating period. If the operating period is an end of season period (such as late December or January) the bias is caused by decreasing downbound ballast transits as shown in the following equation:

$$\text{Daily Ballasted Transits} = DBTRN_{dn} = DBTRN_{dn} \times (1 - BTF)$$

If the operating period is a beginning of season period the bias is caused by increasing the upbound ballast transits as shown in the following equation:

$$\text{Daily Ballasted Transits} = DBTRN_{up} = DBTRN_{up} \times (1 + BTF)$$

Two bias factors are used; one for the validation case and one for projected conditions (future years and season extension). For the validation case the bias traffic factors are BTF4, BTF5, BTF14, and BTF15. For projected conditions, the array BTF(14,4) contains the bias traffic factors for the different months and season extensions.

Pleasure craft and ice lockages are input as the number and direction of lockages per month and are expressed by the variable PCRF. Pleasure craft and ice lockages have locking times equal to the locking times of Class 4 vessels, and are included in the program and output as "Class 3 Vessels".

4.4.1 Subroutine LTRAN

The purpose of subroutine LTRAN is to calculate the loaded transits per operating period as a function of cargo potential (CARGOP), vessel fleet (FLEETN), operating hours (HRS), vessel speed of advance (VSA), cargo shipping demand (DFA), and extended season cargo distribution requirements (TDFCX).

Subroutine LTRAN calculates the monthly loaded transits in four steps.

1. Prohibit certain vessel classes from operating during the winter months.

2. Calculate or assign the portion of total annual transits that occur in each period.

3. Calculate the annual loaded vessel transits of each class needed to transport the desired cargo.

4. Calculate the number of loaded transits occurring in each operating period by class, commodity, and direction.

Step 1. Prohibit certain vessel classes from operating during the winter months.

Because the vessel speed of advance is input as a function of ship class, operating period and season extension, any class vessel can be prohibited from operating during any operating period by setting the vessel speed of advance for that operating period and season extenison to zero. Although we have chosen to do this in subroutine LTRAN (it must be done in subroutine FLEET for consistent results) the vessel speeds of advance can also be set to zero in the data files.

Step 2. Calculate or assign the portion of total annual loaded transits that occur in each period.

The transits are distributed according to three methods, depending on whether the validation case is being run, whether the cargo is to be carried by a specified ship class in extended season, or whether the cargo to be carried will be carried by the normal fleet. If the validation case is being run, transit distribution factors (TDF) are assigned according to data gathered from lock logs and traffic reports. If the cargo is to be carried by a specified ship class in extended season (extended season grain and general cargo), transit distribution factors are assigned through the array TDFCX(5,4) in such a way as to distribute the transits evenly over the extended season. All normal season transits and extended season ore and coal transits are distributed by calculated transit distribution factors according to fleet abilities (VSA), operating conditions (HRS), and cargo shipping demand (DFA), as follows:

Transit Distribution Factor According to Fleet Abilities and Operating Conditions $= TDFC_{i,j,K} = \frac{HRS_{i,K} \times VSA_{j,K}}{HRSYR_i \times VSM_{i,j}}$

For Commodity i, Vessel Class j, and Operating Period K

where $\sum^{K}$ sums up periods over one year

$HRS_{i,j}$ = Operating hours per operating period

$VSA_{j,K}$ = Vessel speed of advance per period

$HRSYR_i$ = Operating hours per year

$VSM_{i,j}$ = Mean vessel speed over the year

Note that $\sum_{j} TDFC_{i,j,K} = 1.0$

Cargo shipping demand is also included in the calculation of the transit distribution via DFA. Relative demand indexes (DIN) ranging from 0 - 99 were read from the data files, and internally converted to absolute demand factors (DFA) that sum to 1.0 when totaled for the year. DFA is incorporated into the transit distribution factors using two iterations of the IAPPROX loop as follows:

$IAPPROX = 1$ (1st Iteration)

$$TDFI_{i,j,K} = TDFC_{i,j,K} \times DFA_K$$

$$TDT_{i,j} = \sum^{K} TDFI$$

$$ENDFAC_{i,j} = 1/TDFT_{i,j}$$

$IAPPROX = 2$

$$(TDFC_{i,j,K})_{new} = (TDFC_{i,j,K})_{old} \times DFA_K \times ENDFAC_{i,j}$$

for commodity i and Vessel Class j

where $\sum^{K}$ sums up period over one year

Step 3. Calculate the annual loaded vessel transits of each class needed to transport the desired cargo.

The cargo distribution by class (CDBC) represents the portion of cargo transported by each class. CDBC is a function of the new fleet (FLEETN), the number of round-trips per year (TRIPYR) and the carrying capacity (CC).

$$\text{Cargo Distribution By Class} = CDBC_{i,j} = \frac{\text{Tons of cargo } i \text{ carried by CLASS } j}{\text{Total Tons of cargo } j}$$

$$CDBC_{i,j} = \frac{FLEETN_{i,j} \times CC_{i,j} \times TRIPYR_{i,j} \times FLOAD_i}{(CARGOP_i)_{up} + (CARGOP_i)_{down}}$$

for Vessel Class i, Direction l, and Commodity j

$FLEETN_{i,j}$ = New fleet

$CC_{i,j}$ = Carrying Capacity

$TRIPYR_{i,j}$ = Number of round-trips per year

$CARGOP_{i,j}$ = Cargo projections

The total annual loaded vessel transits are then:

$$\text{Cargo Transits} = CTRAN_{i,j,l} = \frac{CDBC_{i,j} \times CARGOP_{i,l}}{CC_{i,j} \times FLOAD_i}$$

Step 4. Calculate the number of loaded vessel transits ocurring in each operating period by class, commodity, and direction.

Loaded vessel transits come from two sources, one being the normal season cargo and extended season ore and coal movements and the other being the extended season grain and general cargo movements. Transits due to the former are calculated as follows:

$$\text{Cargo Transits Per Operating Period} = CTRNPM_{i,j,K,l} = CTRAN_{i,j,l} \times TDFC_{i,j,K}$$

where

CTRAN = Cargo transits per year

TDFC = Transit distribution factor (calculated)

for Commodity i, Vessel Class j, Operating Period K, and Direction l.

Input/Output data for subroutine LTRAN is listed in Table 4.7.

4.5 The Ship Dispatch Module (Soo System Only)

The Ship Dispatch Module is contained within the subroutine DISPCH. The purpose of the Ship Dispatch Module is to dispatch the incoming vessel arrivals to the four Soo Locks. Ships are initially dispatched on the basis of size limitations (assigning ships to the smallest lock that the ship will fit into) and later modified to allow ships that were originally dispatched to the MacArthur Lock to use the Poe Lock if the MacArthur Lock experiences significantly more traffic than the Poe Lock and the Poe Lock has not reached its maximum lock utilization. Ships are shifted from the MacArthur Lock to the Poe Lock on the basis of establishing equal waiting times or equal lock utilization at the two locks.

For the expanded locks, that can occur as a capacity expansion measure, the dispatch logic is essentially the same. Ships are allocated to the minimum size lock they can fit through. Input/Output data for subroutine DISPCH is listed in Table 4.8.

Vessels are initially assigned to the Poe and MacArthur Lock as follows:

POE LOCK	MacARTHUR LOCK
Class 11,10,9,8 loaded	Class 7,6,5 loaded
Class 11,10,9 ballasted	Class 8,7,6,5 ballasted

The effective difference in ship arrivals can then be calculated by taking the difference in ship arrivals weighted on locking times.

Class j

$$\text{Effective Difference} = ARTPOE = \frac{ARTCL \times TLOCKM - POECL \times TLOCKP}{TLOCKM + TLOCKP}$$

TABLE 4.7 INPUT AND OUTPUT: SUBROUTINE LTRAN

INPUT

Through the Argument List

IR	Year identifier
ISN	Season extension identifier
IS	Lock system identifier
INDEXC	IAPPROX - 1

Through Common CALCOM

CARGOP(6,2,80)	Cargo potential for the new fleet
HRS(14,4,6)	Operating hours per period
VSA(14,12,6)	Vessel speeds of advance

Through Common MINARY

CC(6,12)	Carrying capacities
DFA(14,4)	Absolute demand fractions
FLEETN(6,12)	New fleet
FLOAD(6)	Loading factor
HRSYR(6)	Operating hours per year
TDF(12,6)	Transit distribution factors - validation case
VSM(12,6)	Mean vessel speeds for the year

OUTPUT

Through Common CALCOM

CTRNPM(6,12,2)	Cargo transits per period

TABLE 4.8 INPUT AND OUTPUT: SUBROUTINE DISPCH

INPUT

Through the Argument List

MN	Month
IS	Lock system
LU	Ship class
ISW	Flag for desired dispatch criteria: 1 = equal waiting time basis 0 = equal lock utilization basis
RHOPOE	Maximum lock utilization for the Poe
JCT	Counter for number of iterations used to dispatch ships according to one of the two dispatch criteria
DATM(14)	Operating hours available per day per operating season

Through Common QUECOM

DLTRN(12,3,14)	Daily loaded transits
DBTRN(12,3,14)	Daily ballasted transits

Through Common Q

RHO(2,1)	Lock utilization in downbound direction for the Poe Lock

OUTPUT

Through Common Q

ARTAR(12,2)	Arrivals at the MacArthur Lock
POEAR(12,2)	Arrivals at the Poe Lock
SABAR(12,2)	Arrivals at the Sabin and Davis Locks
DAVAR(12,2)	Arrivals at the new Davis Lock (larger lock)

where

ARTCL = MacArthur class arrivals

TLOCKM = Typical lock cycle time for the MacArthur Lock

POECL = Poe class arrivals

TLOCKP = Typical lock cycle time for the Poe Lock

If the MacArthur Lock is experiencing a large number of "effective" arrivals, MacArthur class ships are shifted over to the Poe according to the replacement fraction.

$$\text{Replacement Fraction} = RMPCL = \frac{ARTPOE}{ARTCL}$$

Then, additional Poe arrivals are:

$$\text{Additional Poe Arrivals} = POEAR = DLTRN_j \times RPMCL$$

where

$DLTRN_j$ = Daily loaded transits

with j varying from Class 5 to Class 7.

The MacArthur Lock now sees fewer arrivals.

$$\text{MacArthur Arrivals} = ARTAR = DLTRN_j \times (1 - RPMCL)$$

with j varying from Class 5 to Class 7.

To dispatch ships according to either the equal waiting time basis or the equal lock utilization basis the Lock Cycle Time Module and the Queuing Module must be run to calculate the waiting time and the lock utilization. If equal waiting time is desired and the waiting time at the Poe Lock is greater than the waiting time at the MacArthur Lock, the replacement fraction RPMCL is decreased and the waiting time is recalculated with the new distribution of ships between the two locks. If equal lock utilization is desired TLOCKP and TLOCKM are updated to the actual values calculated in the Lock Cycle Time Module and the Dispatch Module is executed again.

Now, if the capacity expansion measure calls for larger locks the dispatch of ships is only slightly different. The program is only capable of doing equal lock utilization basis dispatching when larger locks are built.

If a vessel Class 11 size lock is built vessels are assigned as follows:

Sabin Lock

Class 4 loaded
Classes 4-8 ballast

MacArthur Lock

Classes 5-7 loaded

Poe Lock

Classes 8-10 loaded
Classes 9-10 ballast

New Davis Lock (1350 x 115)

Class 11 loaded and ballast

If Class 12 size locks are built, ships are allocated as follows:

MacArthur Lock

Class 4-7 loaded and ballast

Poe Lock

Classes 8-10 loaded and ballast

Sabin-Davis Lock (1460 x 145)

Classes 11-12 loaded and ballast

Effective arrival differences are calculated similar to above:

$$\text{Effective Difference} = ARDIF_i = \frac{(CL_i \times TLOCKM_i) - (CL_{i+1} \times TLOCKM_{i+1})}{TLOCKM_i + TLOCKM_{i+1}}$$

where

CL_i = Ship arrivals, indexed by lock.

For Class 11 Lock

i = 1 Sabin Lock
i = 2 MacArthur Lock
i = 3 Poe Lock
i = 4 New Davis Lock 1350 x 115

For Class 12 Lock

i = 1 deleted
i = 2,3 same as above
i = 4 Sabin-Davis Lock 1460 x 145

and

$TLOCKM_i$ = Typical lock cycle time, indexed same as above

When done this way, lock utilizations are equalized between all pairs of locks.

$$\text{Replacement Fractions} = RPLCL_i = \frac{ARDIF_i}{CL_i}$$

If the replacement fractions become greater than 0.005, ships are reallocated to the next larger lock until the lock utilizations are equal.

4.6 The Lock Cycle Time Module

The Lock Cycle Time Module is contained in subroutine CYCLTM. Input/Output variables appear in Table 4.9. The purpose of the Lock Cycle Time Module is to calculate the mean lock cycle time, the variance in the lock cycle time, and the lock utilization for each lock and fleet mix. The lock utilization calculations for the expanded locks (Classes 11 and 12) are presently contained in subroutine DISPCH. Before the lock cycle time is calculated, the ship arrivals are assigned to working variables, the arrival rate is determined, and the mean locking time for each direction is calculated.

The working variable for ship arrivals is SOOAR. SOOAR is defined as follows for the three lock systems:

For the Welland and St. Lawrence:

$$SOOAR_{i,j,K} = DLTRN_{j,K} + DBTRN_{j,K}$$

where i includes both the constraining and the non-constraining lock.

TABLE 4.9 INPUT AND OUTPUT: SUBROUTINE CYCLTM

INPUT

Through Argument List

ROHMAX	Maximum lock utilization
RHOPOE	Maximum lock utilization for the Poe Lock

Tnrough Common CALCOM

TMLOCK(12,2,4)	Locking times for individual vessels

Through Common DAT1

DATM(14)	Operating hours per day
STDEV(12,2,4)	Locking time standard deviation
TURNBK(4)	Turnback time for the lock

Through Common QUECOM

DBTRN(12,3,14)	Daily ballast transits
DLTRN(12,3,14)	Daily loaded transits

Through Common Q

ARTAR(12,2)	MacArthur Lock arrivals
POEAR(12,2)	Poe Lock arrivals
SABAR(12,2)	Sabin and Davis Lock arrivals
TIMES(14)	Percentage increase in locking time due to ice

OUTPUT

Through Common Q

CUTF(3,2)	Transit cut-off factor for capacity conditions
RAMDA(3,2)	Vessel arrival rate
RHO(3,2)	Lock utilization
TMCYCL(3,2)	Mean lock cycle time
SDEV(3,2)	Standard deviation of the mean lock cycle time

For the Soo Locks:

$$SOOAR_{i,j,K} = POEAR_{K,j} \qquad i = \text{Poe}$$

$$SOOAR_{i,j,K} = ARTAR_{K,j} \qquad i = \text{MacArthur}$$

$$SOOAR_{i,j,K} = SABAR_{K,j} \qquad i = \text{Sabin and Davis}$$

The mean vessel arrival rate is defined as:

$$RAMDA = \frac{DLTLOCK_{i,j}}{DATM_{l} \times 60}$$

where

$$DTLOCK = \sum^{K} SOOAR_{i,j,K}$$

$\sum^{K}$ sums over the vessel classes

for Lock i, Direction j, and Operating Period l.

The mean one-way lock cycle time is the sum of the locking time for each individual class multiplied by the fraction of transits that each particular class accounts for.

$$TMEAN_{i,j} = \sum^{K} \left(\frac{SOOAR_{i,j,K}}{DTLOCK_{i,j}} \times TMLOCK_{i,j,K} \times TIMES_{l}\right)$$

Similarly, the locking time variance is:

$$AVGVAR = \sum^{K} \left(\frac{SOORAR_{i,j,K}}{DTLOCK_{i,j}} \times STEDV_{i,j,K}\right) + \sum^{K} \left(\frac{SOOAR_{i,j,K}}{DTLOCK_{i,j}}\right.$$

$$\left. \times \left(TMLOCK_{i,j,K} - TMEAN_{i,j,k}\right)^{2}\right)$$

The mean lock cycle time (TMCYCL) is a solution to several simultaneous equations, the combination of which appears in the Lock Cycle Time Module. The mean lock cycle time has as its maximum value the Heavy Balanced Lock Cycle Time, defined as:

$$HBLCT = (TMEAN)_{up} + (TMEAN)_{down}$$

If the mean lock cycle time becomes greater than the heavy balanced lock cycle time, the mean lock cycle time is reassigned as the heavy balanced lock cycle time.

The maximum number of transits per day that the lock can handle with the same fleet mix can then be defined as:

$$CAPCTY = \frac{RHOCAP \times 60 \times DATM}{HBLCT}$$

Lock utilization for each lock and direction is:

$$RHO_{i,j} = RAMDA_{i,j} \times TMCYCL_{i,j}$$

for Lock i and Direction j

where

$TMCYCL$ = Mean lock cycle time.

If the lock utilization for the Sabin becomes greater than 0.7, the Davis Lock is brought into operation. Both locks are assumed to function identically and split the transit demand equally.

If the maximum lock utilization is reached, the transit demand cannot be met and some ships are denied the opportunity to transit the locks. The number of ships that can transit the locks is determined by the cut-off factor:

$$\text{Cut-Off Factor} = CUTF_{i,j} = \frac{RHOCAP}{RHO_{i,j}}$$

for Lock i and Direction j.

Lock cycle time variance is defined as:

$$\text{Lock Cycle Time Variance}_{up} = (VARTM_i)_{up} = (AVGVAR_i)_{up} + 2 \times (1 - (RHO_i)_{dn})^2 + (RHO_i)^2_{dn} \times (AVGVAR_i)_{dn}$$

$$\text{Lock Cycle Time Variance}_{dn} = (VARTM_i)_{dn} = (AVGVAR_i)_{dn} + 2 \times (1 - (RHO_i)_{up})^2 + (AVGVAR_i)_{up} \times (RHO_i)^2_{up}$$

4.7 The Queuing Module

The Queuing Module is contained in subroutine QUEMOD. Input/Output variables appear in Table 4.10. The purpose of the Queuing Module is to determine the mean vessel waiting time and the mean queue length for each lock system and direction of travel. The Queuing Module also calculates the time spent in queues in one complete transit of the lock system (for the Welland and St. Lawrence), and truncates transits when maximum lock utilization is reached.

Mean vessel waiting time and mean queue length are calculated as follows:

$$\text{Waiting Time} = WTQM_{i,j,l} = \frac{RAMDA_{i,j}^{2} \times VARTM_{i,j} + RHO_{i,j}}{2 \times RAMDA_{i,j} \times (1 - RHO_{i,j})}$$

$$\text{Queue Length} = QUE_{i,j,l} = WTQM_{k,j,l} \times RAMDA_{i,j}$$

for Lock i, Direction j, and Operating Period l.

For the Welland and St. Lawrence Systems the waiting time and length of queue for the non-constraining lock is multiplied by the number of non-constraining locks in the system. For all systems, the transits are cut off in the event that the locks reach capacity except for the non-constraining locks in the Welland and St. Lawrence Lock Systems.

$$QUE_{i,j} = QUE_{i,j} \times CALFAC$$

$$\text{Total Waiting Time Per Direction} = WTQM_{i,j} = WTQM_{i,j} \times CALFAC$$

$$\text{Actual Transits} = SOOAR_{i,j,K} = SOOAR_{i,j,K} \times CUTF_{i,j}$$

where $CALFAC$ - number of non-constraining locks

$\sum_{j}$ sums both directions

for Lock i, Vessel Class K, and Operating Period l.

TABLE 4.10 INPUT AND OUTPUT: SUBROUTINE QUEMOD

INPUT

Through Argument List

CALFAC	Number of non-constraining locks (Welland and St. Lawrence)

Through Common Q

CUTF	Transit cut-off factor
RAMDA(4,2)	Vessel arrival rate
RHO(4,2)	Lock utilization
SOOAR(4,12,2)	Vessel transit demand
VARTM(4,2)	Lock cycle time variance

OUTPUT

Through Common QUECOM

QUE(4,2,14)	Mean queue length
WTQM(4,2,14)	Mean vessel waiting time

Through Common Q

SOOAR(4,12,2)	Actual vessel transits

4.8 The Economic Module

The purpose of the Economic Module is to compute the delay cost experienced by each lock and vessel class based on the ship costs and the waiting time. Input/Output variables appear in Table 4.11. The delay cost is the product of waiting time and ship cost per hour, summed for both directions of travel.

$$TDLST_{i,K,l} = \sum^{j} WTQM_{i,j,l} \times SCOST_{j} \times SOOAR_{i,j,K}$$

for Lock i, Vessel Class K, Operating Period l, and

for Commodity i, and Direction j.

4.9 Cargo Tonnage, System Round-Trip, and Waiting Time Module

This module is contained in subroutine CARTON. Input/Output variables appear in Table 4.12. The purpose of the Cargo Tonnage Section is to compute the projected cargo flow and the actual cargo flow for each operating period and commodity.

The purpose of the System Round-Trip and Waiting Time Section is to calculate the time it takes for a vessel to make one round-trip in the Welland Canal or the St. Lawrence River including time spent in queues and slowdowns due to weather (ice) conditions. The system round-trip and waiting time is the sum of the time spent in upbound locks and queues, the time spent in downbound queues and locks, and the time spent between locks and queues. The time spent between locks and queues is multiplied by a transit time increase factor as a function of month that increases transit times due to winter conditions.

$$\text{Actual Cargo Per Operating Period} = CAGOCL_{i,j} = \sum^{j} \sum^{K} (CTRNPM_{i,j,K,l} \times CC_{i,j} \times CUTF_{K})$$

$$\text{Projected Cargo Per Operating Period} = PCARG_{i,l} = \sum^{j} \sum^{K} CTRNPM_{i,j,K,l} \times CC_{i,j}$$

for Commodity i, Vessel Class j, Direction K, and Operating Period l

TABLE 4.11 INPUT AND OUTPUT: ECONOMIC MODULE

INPUT

SCOST(11)	Ship cost
SOOAR(3,11,2)	Actual transits
WTZM(3,2,14)	Waiting time per lock or series of locks

OUTPUT*

TDCST(14,11,3)	Daily delay cost per lock, vessel, class, and operating period

* Has been suppressed for this project.

TABLE 4.12 INPUT AND OUTPUT: SUBROUTINE CARTON

INPUT

Through Argument List	
SYSADD	Time spent in flight locks
SYSFAC	Number of non-constraining locks
SYSTIM	Time spent in transit between locks and queues per round-trip - Welland and St. Lawrence
Through Common CALCOM	
CTRNPM(6,12,2)	Cargo transits per operating period
Through Common MINARY	
CC(6,12)	Carrying capacities
Through Common QUECOM	
WTQM(4,2,14)	Mean waiting time
Through Common Q	
TMCYCL(4,2)	Mean lock cycle time
TTI	Transit time increase
CUTF(4,2)	Transit cut-off factor

OUTPUT

Through Common PRJCOM	
PCARG(3,15,6)	Projected cargo tonnage
Through Common CARGCM	
CAGOCM(6,14)	Actual cargo tonnage
Through Common QUECOM	
ISYSTM(14),	System round-trip and waiting time per operating period

where

CC = Carrying capacities

$CTRNPM$ = Cargo transits per operating period

$CUTF$ = Transit cut-off factor

Time Spent in Upbound Locks and Queues

$$= SYSTUP = (TMCYCL_{up})_{constr.} + SYSFAC \times (TMCYCLE_{up})_{non\text{-}constr.} + SYSADD$$

Time Spent in Downbound Locks and Queues

$$= SYSTDN = (TMCYCL_{dn})_{constr.} + SYSFAC \times (TMCYCLE_{dn})_{non\text{-}constr.} + (WTQM_{dn})_{constr.} + (WTQM_{dn})_{non\text{-}constr.} + SYSADD$$

Time Spent in Transit

$$= SYSTEM = SYSTM \times TTI$$

System R.T. and W.T.

$$= ISYSTM = SYSTUP + SYSTDN + SYSTM$$

4.10 The Output Module

The controlling statements of the Output Module are in subroutine OUTMOD. The purpose of the Output Module is to gather the information generated by the lock capacity analyses and to print the information in tabular form. The output appears in seven routines and two tables printed within the module in the following order:

Projected Cargo	(Subroutine PROJCR)
Fleet Mix	(Subroutine MIX)
Vessel Characteristics	(Subroutine VESCHR)
Yearly Transits	(Subroutine OUTMOD)
Daily Transit Demand	(Subroutine OUTMOD)
Actual Transits	(Subroutine ACTRAN and ACTRN2)
Queuing Information	(Subroutine QUETAB)
Actual Cargo Flow	(Subroutine ACCARG)

The subroutines themselves call subroutine HEADER, which prints the header describing each particular run at the top of each new page. Subroutine QUEUE prints the appropriate table headings for the queuing information table depending on the lock system being run. Each subroutine and table-printing section assigns the old working variables to new variables conveniently dimensioned for printing. Neither the yearly transit information and the daily transit demand tables are printed in subroutines, and a list of input and output for the yearly transit table and the daily transit demand table appear in Table 4.13 and Table 4.14 respectively.

4.10.1 Subroutine HEADER

The purpose of subroutine HEADER is to print the header describing each particular run in terms of year, season extension, locking time range, and fleet response. Subroutine HEADER also contains the carriage controls, date, and page numbers. Input/Output variables appear in Table 4.15.

4.10.2 Subroutine PROJCR

The purpose of subroutine PROJCR is to print the projected cargo tonnage by commodity, operating period, and direction through the locks. Input/Output variables appear in Table 4.16.

4.10.3 Subroutine MIX

The purpose of subroutine MIX is to print out the actual fleet mix by vessel class and commodity. Input/Output variables appear in Table 4.17.

4.10.4 Subroutine VESCHR

The purpose of subroutine VESCHR is to print out the vessel characteristics including vessel utilization, locking times, and cost per hour. Input/Output variables appear in Table 4.18.

4.10.5 Subroutines ACTRAN and ACTRN2

The purpose of subroutines ACTRAN and ACTRN2 is to print out the actual transits by operating period, lock, vessel class, and direction through the locks. Subroutine ACTRAN is called for the Soo Lock System and subroutine ACTRN2 is called for the Welland and St. Lawrence Systems. Input/Output variables appear in Table 4.19.

TABLE 4.13 INPUT AND OUTPUT FOR THE YEARLY TRANSIT TABLE

INPUT

DLTRN(12,3,14)	Average daily loaded transits by vessel class and direction
DBTRN(12,3,14)	Average daily ballast transits by vessel class and direction
DM(14)	Days per operating period
ICTRNP(6,12,2)	Cargo transits per operating year by commodity, vessel class, and direction

OUTPUT

ICTRNP(6,12,2)	Cargo transits per operating year by commodity, vessel class, and direction
ITOTC(2,6)	Cargo transits per operating year by direction and commodity
ILTR(3,12)	Cargo transits per operating year by direction and vessel class
ITOT(3,3)	Total annual vessel transits by direction

TABLE 4.14 INPUT AND OUTPUT FOR THE DAILY TRANSIT DEMAND TABLE

INPUT

DLTRN(12,3,14)	Average daily loaded transits by vessel class and direction
DBTRN(12,3,14)	Average daily ballast transits by vessel class and direction
IBMO(14)	Hollerith field containing the names of the 14 operating periods

OUTPUT

IBMO(14)	Names of the 14 operating periods
TOTDB(3,14)	Average daily ballast transits by direction
TOTDL(3,14)	Average daily loaded transits by direction
TOTDT(3,14)	Average daily total transits by direction
DLTRN(12,3,14)	Average daily loaded transits by vessel class and direction
DBTRN(12,3,14)	Average daily ballast transits by vessel class and direction
DT(12,3,14)	Average daily total transits by vessel class and direction

TABLE 4.15 INPUT AND OUTPUT: SUBROUTINE HEADER

INPUT

Through the Argument List

IS	Loop index on lock systems
INUMB	Page number
IR	Loop index for years
ISN	Loop index for season extensions
ILTML	Loop index for locking time ranges

Through Common HEDCOM

IBMO(14)	Hollerith fields containing operating period names
IYR(8)	Constants representing the years 1976-2040

OUTPUT

IYR(80)	Constants representing the years 1976-2040
ISN	Loop index for season extensions
ILT(3)	Hollerith field containing locking time range titles

TABLE 4.16 INPUT AND OUTPUT: SUBROUTINE PROJCR

INPUT

Through the Argument List

CARF(3,15,80)	Internal commodity forecast working variable
IS	Loop index for lock system
INUMB	Page number
IR	Loop index for year
ISN	Loop index for season extension
ILTML	Loop index for locking time ranges

Through Common HEDCOM

IBMO(14)	Hollerith field containing operating period names

Through Common PRJCOM

IPCARG(3,15,6)	Projected cargo tonnage flow per operating period and commodity
PCARG(3,15,6)	IPCARG in real mode

OUTPUT

IBMO(14)	Hollerith field containing operating period names
IPCARG(3,15,6)	Projected cargo tonnage flow per operating period and commodity
IPCTOT(3,15)	Projected cargo tonnage flow per operating period

TABLE 4.17 INPUT AND OUTPUT: SUBROUTINE MIX

INPUT

LU	Largest vessel class designation per system
IS	Loop index for lock systems
INUMB	Page number
IR	Loop index for years
ISN	Loop index for season extensions
ILTML	Loop index for locking time ranges
SHIP(12,6)	Actual fleet by vessel class and commodity

OUTPUT

SHIP(12,6)	Actual fleet by vessel class and commodity
TSHIP(6)	Actual fleet by commodity
TSHIPS(12)	Actual fleet by vessel class
TTSHIP	Number of ships in the actual fleet
IPCT(6,12)	Shipbuilding percentage by commodity and class
ASHIP	Composite ship class by commodity
ATSHIP	Overall fleet composite ship class

TABLE 4.18 INPUT AND OUTPUT: SUBROUTINE VESCHR

INPUT

Through the Argument List

IS	Loop index for lock systems
LU	Largest vessel class designation per system
LMIN(11)	Minimum vessel length per vessel class
LMAX(11)	Maximum vessel length per vessel class

Through Common CLACOM

TMLOCK(12,2,4)	Locking time per vessel class, direction, and lock

Through Common MINARY

CC(6,12)	Carrying capacities by commodity and vessel class
ZBHF(12)	Ship utilization factor by vessel class

Through Common DAT1

XCAP(12)	Vessel capital cost/hour per vessel class
XSHIP(12)	Vessel operating cost/hour per vessel class

OUTPUT

LMIN(12)	Minimum vessel length per vessel class
LMAX(12)	Maximum vessel length per vessel class
VSM(12,6)	Mean annual vessel speed per vessel class and commodity
ICCC	Carrying capacities
IZBH(12)	Ship utilization factor x 100
ITMLK1	Locking time up
ITMLK2	Locking time down
IXSHIP	Vessel operating cost/hour
IXXCAP	Vessel capital cost/hour
CAPINC(12)	Capacity increase with draft

TABLE 4.19 INPUT AND OUTPUT: SUBROUTINES ACTRAN AND ACTRN2

INPUT

Through the Argument List

LU	Largest vessel class designation per system
IS	Loop index for lock systems
INUMB	Page number
IR	Loop index for years
ISN	Loop index for season extensions
ILTML	Loop index for locking time ranges

Through Common HEDCOM

IBMO(14)	Hollerith field containing operating period names

Through Common CARGCM

SOR(12,12,14)	Number of daily lock arrivals

OUTPUT

IBMO(14)	Hollerith field containing operating period names
SOR(12,12,14)	Number of daily lock arrivals
SORTOT(24)	Total daily lock arrivals

4.10.6 Subroutine QUETAB

The purpose of subroutine QUETAB is to print out the queuing and locking time information by lock and operating period. Subroutine QUETAB calls subroutine QUEUE which prints out the appropriate table headings depending on the lock system. Input/Output variables appear in Table 4.20.

4.10.7 Subroutine QUEUE

The purpose of subroutine QUEUE is to print the appropriate headings for the queuing information depending on the lock system. Input/Output variables appear in Table 4.21.

4.10.8 Subroutine ACCARG

The purpose of subroutine ACCARG is to print the actual cargo tonnage that has transited the locks by operating period and commodity. Input/Output variables appear in Table 4.22.

TABLE 4.20 INPUT AND OUTPUT: SUBROUTINE QUETAB

INPUT

Through the Argument List

IS	Loop index for lock systems
INUMB	Page number
IR	Loop index for years
ISN	Loop index for season extensions
ILTML	Loop index for locking time ranges
LU	Largest vessel class designation per system

Through Common HEDCOM

IBMO(14)	Hollerith field containing operating period names
IYR(80)	Constants representing the years 1978-2050

Through Common CALCOM

HRS(14,4,6)	Operating hours per operating season

Through Common Quecom

IRHO(4,14)	Lock utilization
ISDEV(4,2,14)	Lock cycle time standard deviation
ISYSTM(14)	System round-trip and waiting time
ITMCYC(4,2,14)	Lock cycle time
QUE(4,2,14)	Queue length
WTQM(4,2,14)	Waiting time

OUTPUT

IBMO(14)	Hollerith fields containing operating period names
IHRS(14)	Operating hours per operating period
ITMCYC(4,2,14)	Lock cycle time
ISDEV(4,2,14)	Lock cycle time standard deviation
WTQM(4,2,14)	Waiting time
QUE(4,2,14)	Queue length
IRHO(4,14)	Lock utilization
ISYSTM(14)	System round-trip and waiting time

TABLE 4.21 INPUT AND OUTPUT: SUBROUTINE QUEUE

INPUT

IKNT1	Internal couting index

OUTPUT

-TABLE HEADINGS-

TABLE 4.22 INPUT AND OUTPUT: SUBROUTINE ACCARG

INPUT

Through the Argument List

CARF(3,15,80)	Internal commodity forecast working variable

Through Common CARGCM

CARGOCM(6,14)	Actual cargo tonnage flow by commodity and operating period

Through Common PRJCOM

IPCARG(3,15,15)	Projected cargo tonnage flow

OUTPUT

ICAG(15)	Hollerith field containing commodity names
ICAGO(15,14)	Actual cargo tonnage transported by commodity and operating period
ITFLOW(15)	Actual cargo tonnage transported by commodity
ICFLOW(15)	Actual cargo tonnage transported by operating period

APPENDIX A

PROGRAM VARIABLES

APPENDIX A

PROGRAM VARIABLES

A brief description of all the variables that appear in the common statements (common statements appear alphabetically) followed by variables that appear in the modules but are not present in the common statements.

COMMON CALCOM

CARGOP(6,2,80)	Cargo tonnage potential to be carried by the calculated fleet by commodity, direction, and year
CTRAN(6,12,4)	Cargo transits per year by commodity, vessel class, and direction
CTRNPM(6,12,2)	Cargo transits per operating period, commodity, vessel class, and direction
EXTPT(6,2,80)	Grain and general cargo tonnage potential shipped in the extended season
HRS(14,4,6)	Operating hours per period, season extension, and commodity
TMLOCK(12,2,4)	Locking time by vessel class, direction, and lock
VSA(14,12,4)	Vessel speed of advance per operating period, vessel class, and season extension

COMMON CARGCM

CAGOCM(6,14)	Actual cargo tonnage processed per operating period and commodity
SOR(12,12,14)	Daily transit demand output variable by operating period and vessel class

COMMON COMMOD

Commodity projections input data

AIRORE(80,3)	Iron ore
ALMSTN(80,3)	Limestone
AMIN(80,3)	Non-metalic minerals
BLYRYE(80,3)	Barley and rye
CEMENT(80,3)	Cement
COAL(80,3)	Coal (also internal classification)
CORN(80,3)	Corn
DRYBLK(80,3)	Dry bulk
GENCAR(80,3)	General cargo
OILSD(80,3)	Oilseeds
PETROL(80,3)	Petroleum products
RAWMAT(80,3)	Raw materials
SOY(80,3)	Soybeans
STLPRD(80,3)	Steel products
WHEAT(80,3)	Wheat

Internal Commodity Classifications

BULK(80,3)	Bulk
GENCAR(80,3)	General cargo
GRAIN(80,3)	Grain
ORE(80,3)	Ore
STONE(80,3)	Stone

COMMON DAT1

BTF(14,4)	Bias traffic factor by operating period and season extension
CAREX1(6,2,80)	Cargo tonnage potential to be carried by the calculated fleet during season extension 1 by commodity direction and year
CAREX2(6,2,80)	Identical to CAREX1 above except for season extension 2 instead of extension 1
DATM(14)	Operating hours available per day per operating season
DIN(14,4)	Demand indexes per operating period and season extension
GBAL(12)	Total annual ballasted transits per vessel class
GLOAD(12)	Total annual loaded transits per vessel class
IZBH(12)	Ship utilization factor x 100 (integer)
LYEAR(80)	Year index
PCRF(14,2)	Pleasure craft and ice lockages per operating period and direction
SCOST(12)	Ship capital + operating costs per hour and vessel class
STDEV(12,2,4)	Standard deviation in locking times by vessel class, direction, and lock
TLTML2(12,2,4)	Low locking times per vessel class, direction, and lock
TLML3(12,2,4)	High locking times per vessel class, direction, and lock
TURNBK(4)	Turnback time per lock

XCAP(12)	Ship capital costs per hour by vessel class
XSHIP(12)	Ship operating costs per hour by vessel class
ZB(12)	Ship utilization factors by vessel class

COMMON HEDCOM

IBMO(14)	Hollerith fields containing the names of the 14 operating periods
IYR(80)	Constants representing the sequential years (1978-2050)

COMMON MINARY

ADDPCT(6,12)	Shipbuilding percentages by commodity and vessel class
BASEFT(6,12)	Base fleet
CAPINC(12)	Ship capacity increase with increase in depth
CC(6,12)	Carrying capacities by commodity and vessel class
DFA(14,4)	Absolute demand factors per period and season extension
DISTN(2,6)	Mean distance between ports by direction and vessel class
EMPTY(6,12)	Unloading rate in short tons per hour by commodity and vessel class
FILL(6,12)	Loading rate in short tons per hour by commodity and vessel class
FLEETN(6,12)	New zero-backhaul fleet by commodity and vessel class
FLOAD(6)	Loading factor to account for broken stowage per commodity
HRSYR(6)	Operating hours per year per commodity

PO(80,12)	Phase out fractions per year and vessel class
REDFT(12)	Fleet reduction factor to convert the zero-backhaul new fleet into the actual fleet
TDF(12,14)	Transit distribution factors for the validation year by vessel class and operating period
TRIPYR(6,12)	Number of round-trips a single ship can make in one operating year by commodity and vessel class
VSM(12,6)	Mean vessel speed per vessel class and commodity
WDIST(6)	Mean distance between major commodity ports, both directions, by commodity
ZBHF(12)	Ship utilization factors by vessel class

COMMON PRELIM

ISES(4)	Season extension flags
ILTM(3)	Locking time range flags

COMMON PRJCOM

IPCARGO(3,15,15)	Projected cargo tonnage flow per operating period and commodity in integer format
PCARG(3,15,6)	Projected cargo tonnage (IPCARG) in real format

COMMON Q

ARTAR(12,2)	Number of ships that are arriving at the MacArthur Lock per day by vessel class and direction
ARTCL(2)	Number of ships that can be assigned to the MacArthur Lock per day by direction

ARTPOE(2)	Effective difference in daily ship arrivals between the Poe and MacArthur Locks
AVGVAR(4,2)	Locking time variance
CAPCTY(4,2)	Maximum number of daily transits possible before maximum lock utilization is reached by lock and direction
CUTF(3,2)	Portion of transits that are processed if capacity is reached by lock and direction
DTLOCK(3,2)	Total number of daily arrivals by lock and direction
LMAX(12)	Maximum vessel length per class
LMIN(12)	Minimum vessel length per class
MONRAY(14)	Array containing the order operating periods are analyzed
POEAR(12,2)	Number of ships that do arrive at the Poe Lock per day by vessel class and direction
POECL(2)	Number of ship arrivals that fit through the Poe Lock only per day
RAMDA(4,2)	Vessel arrival rate be lock and direction
RHO(4,2)	Lock utilization by lock and direction
RPMCL(2)	Replacement fraction in ship dispatch module for transfer of ships from the MacArthur Lock to the Poe Lock by direction
[illegible]P(12,2)	Number of daily arrivals to the Sabin and Davis Locks by vessel class and direction
SDEV(4,2)	Locking time standard deviation by lock and direction

SHIP(12,6)	Actual fleet by vessel class and commodity
SOOAR(4,12,2)	Daily vessel arrivals per lock by vessel class and direction
TBAL(14,12)	Number of ballast transits per day by operating period and vessel class
TBALT(12)	Total annual ballast transits per vessel class
TDCST(4,12)	Daily delay cost per lock and vessel class
TIMES(14)	Locking time increase per operating period due to winter
TLOAD(14,12)	Number of loaded transits per day by operating period and vessel class
TLOADT(12)	Total annual loaded transits per vessel class
TLOCKM(4,2)	Typical locking time for each of the Soo Locks by direction
TMCYCL(4,2)	Mean lock cycle time by lock and direction
TMEAN(4,2)	Mean one-way locking time by lock and direction
TTI(14)	Transit time increase by operating period due to winter
VARTM(4,2)	Variance of mean lock cycle time by lock and direction
VARTNB	Variance in the lock turnback time
YESTRN	Logical variable indicating if transits occurred in each operating period

COMMON QUECOM

CAGOCL(6,12)	Cargo carried per vessel class and commodity per operating period
DBTRN(12,3,14)	Average daily ballast transits by vessel class, direction and operating period
DLTRN(12,3,14)	Average daily loaded transits by vessel class, direction, and operating period
DM(14)	Days per month
DT(12,3,14)	Average daily loaded + ballast transits by vessel class, direction, and operating period
ICTRNP(6,12,2)	Cargo transits per operating year by commodity, vessel class, and direction
IDBTRN(12,3)	Total ballasted transits per operating period year by vessel class and direction
IDLTRN(12,3)	Total loaded transits per operating year by vessel class and direction
IHRS(14)	Maximum operating hours per operating season
ILTR(3,12)	Cargo transits per operating period by direction and vessel class
IRHO(4,14)	Lock utilization x 100 by lock and operating period
ISDEV(4,2,14)	Lock cycle time standard deviation by lock, direction, and operating period
ISYSTM(14)	System round-trip and waiting time for the Welland and St. Lawrence operating period
ITLTR(3,12)	Total annual vessel transits by direction and vessel class

ITMCST(15,12,4)	Delay cost per operating period by vessel class and lock
ITMCYC(4,2,14)	Mean lock cycle time by lock, direction, and operating period
ITOT(3,3)	Total annual vessel transits by direction
ITOTC(2,6)	Cargo transits per operating year by direction and commodity
ITTCST(12,3)	Delay cost
QUE(4,2,14)	Average queue length by lock, direction and operating period
TOTDB(3,14)	Average daily ballast transits per direction and operating period
TOTDL(3,14)	Average daily loaded transits per direction and operating period
TOTDT(3,14)	Average daily loaded + ballast transits by direction and operating period
WTQM(4,2,14)	Average waiting time by lock, direction, and operating period
XDBTRN(12,2)	IDBTRN (Real)
XDLTRN(12,2)	IDLTRN (Real)

VARIABLES NOT IN COMMON

ABTEST	Very small number for logical comparisons
ACARGO	Actual cargo carried per operating period, commodity, vessel class, and direction
ADDSHP(6,12)	Additional new ships built to meet the cargo tonnage potential by commodity and vessel class
ALLSHP(6,12)	Number of additional ships built by commodity and vessel class

ANCAP(6)	Remaining fleet cargo transport capacity by commodity
BTF4	Base year bias traffic factor for early April
BTF5	Base year bias traffic factor for late April
BTF13	Base year bais traffic factor for early December
BTF14	Base year bias traffic factor for late December
CALFAC	System queue length and waiting time multiplier (number of non-constraining locks)
CARGON	Cargo not transported by the remaining fleet
CARGT(12,2)	Total cargo transits per year by vessel class and direction
CDBC(6,12)	Cargo distribution fractions by commodity and vessel class
COMSHA(6)	Composite ship to be added to fleet by commodity
DELSHP(6,12)	Number of ships that must be deleted from the remaining fleet if the fleet it too large
DIFROE	The difference between lock utilization of the separate locks at the Soo
DRAFT	New system draft for a capacity expansion measure
ENDFAC(6,12)	Partial calculation of TDFC in subroutine LTRAN; used to incorporate cargo shipping demand
EMPTY2	Difference between upbound and downbound daily loaded transits (DLTRN)

FACTOR	Cargo projections multiplier
FLEETR(6,12)	Remaining fleet by commodity and vessel class
HBLCT	Heavy balanced lock cycle time
HOLD	Intermediate variable used to flip upbound and downbound daily transit demands for printing
GONOGO	Data file go/no go flag
IAPROX	Loop index for approximation iterations
ICAGO(6,14)	Actual cargo transported by commodity and month
ICAP	Intermediate variable used for capacity check
ICAPX	Capacity expansion measure implementation flag (0 = no, 1 = yes)
ICCC	Carrying capacities (Integer)
ICFLOW(15)	Actual cargo transported by month
IDEBUG	Logical variable used for printing a debugging file from internal WRITE statements
IDEC	Variable used for year counting
IDEC1	Variable used for year counting
IKNT1	Internal counting mechanism for queuing output
ILOCK	Individual lock label at the Soo
ILT(3)	Hollerith field containing locking time range titles
ILTM(3)	Flag for desired locking time range
ILTML	Loop index for locking time ranges

IND	INDVLK + 1
INDEXC	IAPPROX-1
INDVLK	Individual lock loop index variable
INUMB	Page number
IPCTOT(3,15)	Projected cargo tonnage by direction and operating period
IPGS	Total number of pages per run
IRINC	Intermediate variable for year counting
IRR	Intermediate variable for year counting
IR	Loop index for years
IS	Data file identifier
ISN	Loop index for season extensions
ISW	Ship dispatch criteria index
ISES(4)	Flag for desired season extensions
ISYST	Lock system loop index
ITFLOW(6)	Actual cargo tonnage transported per year by commodity
ITMLK1	Locking time up
ITMLK2	Locking time down
IXSHIP	Vessel operating costs
IXCAP	Vessel capital costs
IY	Intermediate variable for year counting
IYEAR	Intermediate variable for year counting
IYRCAP	Year capacity is reached

J1 J10 J20 JCT JYR	Intermediate variables for year counting after capacity expansion measure implementation
KU	Number of different locks per system
LC	Loop index per vessel class
LOCKS	Capacity expansion measure flag for the option of increasing lock size when system draft is increased
LU	Highest vessel class per system
MC	Loop index for commodity
MEASUR	Capacity expansion measure label variable
MN	Loop index for operating period
NEWLU	New maximum vessel class for capacity expansion measures
NEXPG	Carriage control to start each table on a new page
NHOWTO	Locking time reduction option label
RHOMAX	Maximum lock utilization
RHOPOE	Maximum lock utilization for the Poe Lock
SHPCAP(6,12)	Annual cargo transport capacity of the remaining fleet by commodity and vessel class
SORTOT(18)	Daily vessel arrivals dimensioned for printing
SYSADD	Time spent in flight locks per round-trip
SYSFAC	Lock cycle time muliplier (Number of non-constraining locks) - Welland and St. Lawrence

SYSTIM	Time spent in transit between locks and queues per round-trip - Welland and St. Lawrence
TCARG	Total cargo up and down
TDFC(12,14)	Transit distribution factors by vessel class and operating period
TDFI	Parital calculation of TDFC; used to include cargo shipping demand
TDFT	Partial calculation of TDFC; used to include cargo shipping demand
TDIN	Total of the input demand indexes (DIN)
TIMELK(12)	Approximate time spent in locks (unconstrained per round-trip - Welland and St. Lawrence
TRIPTM(6,12)	Time per round-trip by commodity and vessel class
TSHIP(6)	Number of ships in the actual fleet by commodity
TSHIPS(12)	Number of ships in the actual fleet by vessel class
TTSHIP	Total number of ships in the actual fleet
TURNBK(3)	Lock turnback time per lock

APPENDIX B

PROGRAM LISTING

```
C$    DEBUG
C$    ARRAYS
      PROGRAM ANALOK(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,
     +TAPE8,TAPE9,HELP,DEBUG=HELP)
C
C      PROGRAM ANALOK:  GL/SLS LOCK CAPACITY MODEL
C
C      ARCTEC, INC.
C      9104 RED BRANCH ROAD
C      COLUMBIA, MD 21045, USA
C
C      WRITTEN:
C      AUTHOR:      J. KWANGSE KIM
C      MODIFIED:    ALLEN REID 12/4/80
C
C      LANGUAGE:    FORTRAN
C      PURPOSE:     THIS PROGRAM PREDICTS THE POINT WHEN THE SOO,
C                   WELLAND AND SEAWAY LOCKS REACH CAPACITY AND ANALIZES
C                   THE FACTORS CAUSING CAPACITY.
C
C
C
      IMPLICIT INTEGER (I)
C
      COMMON /MEDCOM/  IBMO(14),IYR(80)
      COMMON /PRJCOM/ IPCARG(3,15,15),PCARG(3,15,6)
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /MINARY/ NASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /PRELIM/ IIT(3),ISES(4),ILTM(3)
      COMMON /DAT1/ BTF(14,4),LAREX1(6,2,80),LAREX2(6,2,80),
     + DATM(14),DIN(14,4),DIST(6),
     + EXTP1(6,2,80),EXTP2(6,2,80),
     + IZBM(12),LYEAR(80),ODAYS(12),PCRF(14,2),SCOST(12),STDEV(12,2,4),
     + TLTML2(12,2,4),TLTML3(12,2,4),TURNBK(4),UNLOAD(12),XCAP(12),
     + XSHIP(12),ZB(12),GBAL(12),GLOAD(12)
      COMMON /QUECOM/ CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDNTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
      COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPALL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
      COMMON /COMMOD/ WHEAT(80,3),SOY(80,3),BLYRYE(80,3),CORN(80,3),
     +  OILSD(80,3),ALMSTN(80,3),AIRORE(80,3),RAWMAT(80,3),
     +  COAL(80,3),PETROL(80,3),DRYBLK(80,3),GENCAR(80,3),
     +  STLPRD(80,3),GRAIN(80,3),STONE(80,3),ORE(80,3),BULK(80,3),
     +  GNCAR(80,3),CEMENT(80,3),AMIN(80,3)
C
      DIMENSION REDLT(3,2,5)
      DIMENSION IROSUM(4)
      DIMENSION CARF(3,15,80)
      INTEGER GONOGO
      LOGICAL YESTRN,IDEBUG
C
      DATA IBMO/8HJANUARY ,8HFEBRUARY,8HMARCH   ,8H1 APRIL ,8H2 APRIL ,
     + 8HMAY     ,8HJUNE    ,8HJULY    ,8HAUGUST  ,8HSEPTEM  ,
     + 8HOCTOBER ,8HNOVEMBER,8H1 DECEM ,8H2 DECEM /
      DATA DM/31.,29.,31.,15.,15.,31.,30.,31.,31.,30.,31.,30.,15.,
     + 15./
      DATA TIMES / 1.10,1.20,1.20,1.05,1.00,1.00,1.00,1.00,
     + 1.00,1.00,1.00,1.00,1.00,1.05 /
      DATA RHOMAX,RHOPOE / 0.98,0.98 /
      DATA MONRAY/4,5,6,7,8,9,10,11,12,13,14,1,2,3/
      DATA TTI/1.28,1.93,1.93,1.00,1.00,1.00,1.00,1.00,1.00,
     + 1.00,1.00,1.00,1.05,1.05/
      DATA NEXPG,ABTEST / 1,.001 /
      DATA TLOCKM/83.,65.,83.,65.,145.,125.,145.,125./
      DATA LMIN/0,0,0,0,600,400,700,750,850,990,1100,1200/
      DATA LMAX/0,0,0,599,699,699,749,849,989,1099,1199,1299/
      DATA PCARG,CAGOCM,SOR,ADDTRN,CARGOP,CTRAN,CTRNPM,EXTPT,
```

```
     + HRS,TMLOCK,VSA,BASEFT,CC,DFA,DISTN,EMPTY,FILL,FLEETN,FLOAD,
     + HRSYR,PO,REDFT,TDF,TRIPYR,VSM,WDIST,ZBHF,ADDPCT,CAPINC,BTF,
     + CAREX1,CAREX2,DATM,DIN,DIST,EXTP1,EXTP2,ODAYS,PCRF,SCOST,
     + STDEV,TLTML2,TLTML3,TURNBK,UNLOAD,XCAP,XSHIP,ZB,GBAL,GLOAD,
     + CAGOCL,DBTRN,DLTRN,DT,QUE,TOTDB,TOTDL,TOTDT,WTQM,XDBTRN,
     + XDLTRN,ARTCL,ARTPOE,AVGVAR,CAPCTY,CUTF,DTLOCK,POEAR,POECL,
     + RAMDA,RHO,RPMCL,SABAR,SDEV,SHIP,SOOAR,TBAL,TBALT,TDCST,TDFCX,
     + TLOAD,TLOADT,TMCYCL,TMEAN,VARTM,WHEAT,SOY,BLYRYE,CORN,OILSD,
     + ALMSTN,AIRORE,RAWMAT,COAL,PETROL,DRYBLK,GENCAR,STLPRD,GRAIN,
     + STONE,ORE,BULK,GNCAR,CEMENT,AMIN,ARTAR,DCST,VARTNB,
     +  REDLT / 22962*0.0 /
      DATA IYR,IPCARG,IIT,ISES,ILTM,IZBH,LYEAR,IDBTRN,ICTRNP,IDLTRN,
     + IHRS,ILTR,IRHO,ISDEV,ISYSTM,ITLTR,ITMCST,ITMCYC,ITOT,ITOTC,
     + ITTCST,ICAP,ICAPX,IYRCAP,J,K,MEASUR,NHOWTO /2500*0/
C
    9 FORMAT(I1)
    5 FORMAT(1X)
  972 FORMAT(50X,8A2,2X,4A2)
  510 FORMAT (I1,1X,I1)
C
 5000 IDEBUG=.TRUE.
C
C
C
C ***** SYSTEM LOOP *****
C
 5010 DO 100 ISYST=1,3
 5020    READ(ISYST,510)GONOGO,IS
         IF(GONOGO.EQ.0) GOTO 100
C ISW=1     EQUAL WAITING TIME BASIS
C    ISW=0     EQUAL LOCK UTILIZATION BASIS
      VARTNB=2.
      ISW=0
      INUMB=0
      JCT=0
      KU=2
      IF(IS.EQ.1) KU=3
C
C  THE RUN SET MODULE
 5030       CALL READIN (ISYST,IS,LU,KU,FACTOR,CALFAC,SYSFAC,
     +       SYSADD,SYSTIM,BTF4,BTF5,BTF13,BTF14,TDFCX,IDEBUG,
     +        CARF)
C
C ***** LOCK CYCLE TIME LOOP *****
C
            DO 110 ILTML=1,3
            IF( ILTM(ILTML).NE.1 ) GOTO 110
               IF( ILTML.EQ.2 ) CALL TLOCMT(TLTML2,LU,IS)
               IF( ILTML.EQ.3 ) CALL TLOCMT(TLTML3,LU,IS)
C
C  INTERPOLATE THE COMMODITY FORCASTS AND RETIREMENT
C  PERCENTAGES FOR INTERMEDIATE YEARS
C
         DO 8500 IR=10,14,2
            YEAR=IR*1.0-8
            DO 8530 MC= 1,6
               DO 8540 ND= 1,2
                  IF (ISES(1) .EQ. 1) GO TO 8521
                CAREX2(MC,ND,IR)=CAREX2(MC,ND,8)+(YEAR/7.0)*
     +           (CAREX2(MC,ND,15)-CAREX2(MC,ND,8))
                  GO TO 8540
 8521            CAREX1(MC,ND,IR)=CAREX1(MC,ND,8)+(YEAR/7.0)*
     +           (CAREX1(MC,ND,15)-CAREX1(MC,ND,8))
 8540          CONTINUE
 8530       CONTINUE
            DO 8531 LC= 4,LU
            PO(IR,LC)=PO(8,LC)+(YEAR/7.0)*(PO(15,LC)-PO(8,LC))
 8531       CONTINUE
 8500     CONTINUE
       DO 8510 IR=16,18,2
             YEAR=IR*1.0-15.0
            DO 8570 MC= 1,6
               DO 8580 ND= 1,2
                  IF (ISES(1) .EQ. 1) GO TO 8522
                CAREX2(MC,ND,IR)=CAREX2(MC,ND,15)+(YEAR/5.0)
     +      *(CAREX2(MC,ND,20)-CAREX2(MC,ND,15))
                  GO TO 8580
 8522            CAREX1(MC,ND,IR)=CAREX1(MC,ND,15)+(YEAR/5.0)
     +           *(CAREX1(MC,ND,20)-CAREX1(MC,ND,15))
 8580          CONTINUE
 8570       CONTINUE
            DO 8571 LC= 4,LU
                  PO(IR,LC)=PO(15,LC)+(YEAR/5.0)*(PO(20,LC)-PO(15,LC))
 8571       CONTINUE
 8510     CONTINUE
```

```
      DO 8550 IY=2,7
            DO 8590 IYEAR=2,8,2
               IR=IY*10+IYEAR
              IF(IR.GT.80) GO TO 8590
               IDEC=IY*10
               IDEC1=(IY+1)*10
               YEAR=IYEAR*1.0
 8560       DO 8600 MC= 1,6
              DO 8610 ND= 1,2
                IF (ISES(1) .EQ. 1) GO TO 8523
               CAREX2(MC,ND,IR)=CAREX2(MC,ND,IDEC)+(YEAR/10.0)
     +          *(CAREX2(MC,ND,IDEC1)-CAREX2(MC,ND,IDEC))
                GO TO 8610
 8523          CAREX1(MC,ND,IR)=CAREX1(MC,ND,IDEC)+(YEAR/10.0)*
     +           (CAREX1(MC,ND,IDEC1)-CAREX1(MC,ND,IDEC))
 8610         CONTINUE
 8600       CONTINUE
            DO 8601 LC= 4,LU
             PO(IR,LC)=PO(IDEC,LC)+(YEAR/10.0)*(PO(IDEC1,LC)
     +-PO(IDEC,LC))
 8601       CONTINUE
 8590    CONTINUE
 8550     CONTINUE
C
C  ***** SEASON EXTENSIN LOOP *****
C
 5040       DO 120 ISN= 1,2
            IF(ISES(ISN) .NE. 1) GO TO 120
               IF ( ISN .EQ. 1 ) CALL SESONS(ISN,FACTOR,CAREX1,
     +            EXTP1,TDIN,DIN)
               IF ( ISN .EQ. 2 ) CALL SESONS(ISN,FACTOR,CAREX2,
     +            EXTP2,TDIN,DIN)
C
C ***** YEARLY CYCLE LOOP *****
C
       DO 129 IRINC=8,80,2
           IF(IRINC.EQ.16) IR=15
            IF(IRINC.EQ.16) GO TO 7510
 7500       IR=IRINC
C CONVERT YEAR SUBSCRIPTS INTO ACTUAL YEAR
 7510       IYR(IR)=1970+IR
                     DO 781 LC= 3,LU
                      REDFT(LC)=1.0
  781               CONTINUE
C
C ***** APPROXIMATION CYCLE LOOP *****
C
 5050                DO 140 IAPROX=1,3
                      INDEXC=IAPROX-1
C
C  THE FLEET FORECAST MODULE
                     CALL FLEET (INDEXC,IR,ISN,LU,IS,SYSFAC,SYSADD)
                      DO 9700 LKO= 1,4
                       IROSUM(LKO)= 0
 9700                 CONTINUE
C
C ***** STEP THROUGH MONTHS STARTING WITH EARLY APRIL LOOP *****
C
 5060                DO 150 MNNR=1,14
                      MN=MONRAY(MNNR)
C
C  THE TRANSIT FORECAST MODULE
                     DFA(MN,ISN)=DIN(MN,ISN)/TDIN
  211 CONTINUE
                     CALL LTRAN (IR,ISN,LU,MN,IS,INDEXC,
     +                YESTRN,TDFCX)
     +               CALL TFRCT(LU,MC,MN,ABTEST,IR,ISN,
     +                BTF4,BTF5,BTF13,BTF14)
                     IF( .NOT.(YESTRN) ) DBTRN(3,2,MN)=0
                     IF( .NOT.(YESTRN) )ISYSTM(MN)=0
 5070                IF( IAPROX.NE.3 )GOTO 150
                      RHO(2,1)=0.
                      JCT=0
                      IF(IS.NE.1)GOTO 172
C
C THE SHIP DISPATCH MODULE
   71                      CONTINUE
                            CALL DISPCH(MN,LU,IS,ISW,JCT,RHOPOE,
     +                       DATM)
  172                       CONTINUE
C
```

```
C  THE LOCK CYCLE TIME MODULE
C  THE QUEUEING MODULE
 5080                              LKST= 1
                                   IF (IS .EQ. 1 .AND. LU .GE. 12)
     +                               LKST= 2
                                   DO 170 LK= LKST,KU
                                        CALL CYCLTM(LK,LU,IS,MN,RHOCAP,
     +                                   RHOMAX,RHOPOE,TMCY,VARTNB)
                                        CALL QUEMOD(LK,MN,IS,CALFAC,LU)
  170                                 CONTINUE
C
C  IF NECESSARY, RETURN TO THE DISPATCH MODULE
                                    JCT=JCT+1
                                    IF(IS.NE.1) GO TO 201
                                    IF(ISW.EQ.1) GO TO 203
                                       IF(JCT.EQ.2) GO TO 201
                                          DO 202 ND=1,2
                                          DO 171 LK= LKST,KU
                                              IF (LU .GE. 11)
     +                                         TLOCKM(LK,ND)=
     +                                         TMCYCL(LK,ND)
  171                                    CONTINUE
                                         IF (LU.LE.10)TLOCKM(2,ND)
     +                                    = TMCYCL(1,ND)
                                         IF (LU.LE.10) TLOCKM(3,ND)
     +                                    = TMCYCL(2,ND)
  202                                     CONTINUE
                                          GO TO 71
  203                                  CONTINUE
                                      IF(RPMCL(1).GE.0.AND.WTQM(1,1,MN)
     +                                  .LT.WTQM(2,1,MN) )GOTO 71
C
C  THE ECONOMICS MODULE
C
C  THE ECONOMICS MODULE COMPUTES THE MONTHLY DELAY COST BY LOCK AND
C  VESSEL CLASS
  201                              CONTINUE
                                   DO 420 LK=LKST,KU
                                      DO 410 LC=4,LU
                                         TDCST(LK,LC)=0.
                                         DO 400 ND=1,2
                                            DCST=WTQM(LK,ND,MN)*SCOST(LC)*
     +                                       SQOAR(LK,LC,ND)/1000.
                                            TDCST(LK,LC)=TDCST(LK,LC)+DCST
  400                                    CONTINUE
 5090                                    ITMCST(MN,LC,LK)=TDCST(LK,LC)*DM
     +                                    (MN)+0.5
  410                                 CONTINUE
  420                              CONTINUE
C
C THE CARGO TONNAGE MODEL
                                   CALL CARTON(LU,LK,MN,IS,SYSFAC,SYSADD,
     +                              SYSTIM,IROSUM)
  150                      CONTINUE
  140                    CONTINUE
C
C ***** END STEP THROUGH MONTHS *****
C ***** END APPROXIMATION LOOP *****
C
C  CHECK TO SEE IF CAPACITY HAS BEEN REACHED
C
                     ICAP= 0
                     IF (IS .EQ. 1) GO TO 7010
                        IF(IROSUM(1) .GE. 630) ICAP= 1
                     GO TO 7000
 7010                DO 7040 LK= 1,4
                     IF (LU .GE. 12 .AND. LK .EQ. 1) GO TO 7040
                     IF (LU .LE. 10 .AND. LK .EQ. 4) GO TO 7040
                        IF (IROSUM(LK) .GE. 630) ICAP= LK
 7040                CONTINUE
 7000                CONTINUE
                     IF(ICAP .EQ. 0) GO TO 7550
C  IF CAPACITY WAS REACHED DETERMINE WHAT YEAR
                        IF (IROSUM(ICAP) .GT. 658) GO TO 7050
                   IYRCAP=1970+IR
                     GO TO 7550
 7050              IYRCAP=1969+IR
C
C  ***** THE OUTPUT MODULE *****
C
 7550 CONTINUE
      CALL OUTMOD(LC,LU,IS,INUMB,IR,ISN,ILTML,NEXPG,ICAP,CARF)
```

```
  131 IF (ICAP .EQ. 0) GO TO 130
 7060             WRITE (8,7069)
 7069             FORMAT (3(/))
                  WRITE (8,7070) IYRCAP
 7070             FORMAT (38X,29H**** CAPACITY WAS REACHED IN ,I4,
     +              1X,4H****)
C
C    IS A CAPACITY EXPANSION MEASURE TO BE IMPLEMENTED?
C
      READ(ISYST,6000) ICAPX
 6000 FORMAT(I1)
      IF(ICAPX.EQ.0) GO TO 100
C READ IN THE CAPACITY EXPANSION MEASURE
      READ(ISYST,6000)MEASUR
      IF(MEASUR.EQ.1) GO TO 6020
      IF(MEASUR .EQ. 2 .OR. MEASUR .EQ. 3) GO TO 6040
      IF(MEASUR.EQ.4) GO TO 6050
 6020 IF(ICAPX.GT.1) GO TO 6021
C
C CAPACITY EXPANSION MEASURE 1: REDUCE LOCKING TIME
C
      READ(ISYST,6060)((REDLT(IS,ND,K),ND=1,2),K=1,5)
 6060 FORMAT(2F7.2)
 6021 READ(ISYST,6000) NHOWTO
      DO 6080 LC=4,LU
         DO 6070 ND=1,2
            DO 6090 J=1,4
               TMLOCK(LC,ND,J)=TMLOCK(LC,ND,J)*(1.0-REDLT(IS,ND,
     +           NHOWTO))
               TLTML2(LC,ND,J)=TLTML2(LC,ND,J)*(1.0-REDLT(IS,ND,
     +           NHOWTO))
               TLTML3(LC,ND,J)=TLTML3(LC,ND,J)*(1.0-REDLT(IS,ND,
     +           NHOWTO))
 6090       CONTINUE
 6070    CONTINUE
 6080 CONTINUE
      DO 6081 ND=1,2
      REDLT(IS,ND,NHOWTO)=REDLT(IS,ND,NHOWTO)*100.0
 6081 CONTINUE
      WRITE(8,7069)
      WRITE(8,6100) REDLT(IS,1,NHOWTO),REDLT(IS,2,NHOWTO)
 6100 FORMAT(23X,45H CAPACITY INCREASED BY REDUCING LOCKING TIME ,
     +  F4.1,16HX DOWNBOUND AND ,F4.1,10H X UPBOUND)
      IF(NHOWTO.EQ.1) WRITE(8,6031)
      IF(NHOWTO.EQ.2) WRITE(8,6032)
      IF(NHOWTO.EQ.3) WRITE(8,6033)
      IF(NHOWTO.EQ.4) WRITE(8,6034)
      IF (NHOWTO .EQ. 5) WRITE(8,6035)
 6031 FORMAT(32X,38H**** TRAVELING KEVELS AND WINCHES WERE,1X,
     +  16HCONSTRUCTED ****)
 6032 FORMAT(38X,44H**** SHIP SPEED INTO LOCK WAS INCREASED ****)
 6033 FORMAT(38X,44H**** LOCK CHAMBERING TIME WAS DECREASED ****)
 6034 FORMAT(36X,48H**** TRAFFIC CONTROL SYSTEM WAS IMPLEMENTED ****)
 6035 FORMAT (40X,41H***** NONSTRUCTURAL MAXIMUM UTILITY *****)
      GO TO 130
C
C  CAPACITY EXPANSION MEASURE 3: INCREASE ALLOWABLE SHIP DRAFT
C
 6040 READ (ISYST,6066) DRAFT
      READ (ISYST,6000) LOCKS
 6066 FORMAT (F6.2)
      IF (DRAFT .LE. 25.75) GO TO 6030
      DO 6068 LC= 4,LU
         DO 6067 MC= 1,6
            CC(MC,LC)= CC(MC,LC)+((DRAFT-25.5)*12.0)*CAPINC(LC)
 6067    CONTINUE
 6068 CONTINUE
      WRITE (8,7069)
      WRITE (8,6069) DRAFT
 6069 FORMAT(21X,48H**** CAPACITY INCREASED BY INCREASING ALLOWABLE ,
     +  13HSHIP DRAFT TO,F6.2,10H FEET ****)
      IF (LOCKS .GE. 1) GO TO 6030
      GO TO 130
C
C  CAPACITY EXPANSION MEASURE 2: CONSTRUCT LARGER LOCKS
C
C  READ IN THE NEW MAXIMUM SHIP SIZE
 6030 READ (ISYST,6043)
      READ (ISYST,6041) NEWLU
 6041 FORMAT (I2)
```

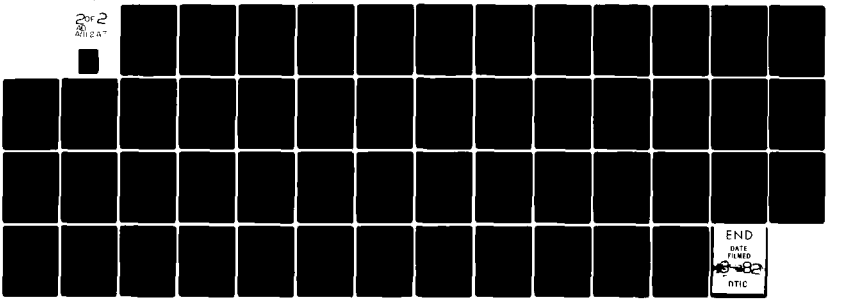
```
      LUP= LU+1
C  READ NEW SHIP UTILIZATION FACTORS
      IF(IS .NE. 1) READ (ISYST,6042) (ZBHF(LC),LC=LUP,12)
      IF (IS .EQ. 1) READ (ISYST,4042) (ZBHF(LC),LC=LUP,12)
 4042 FORMAT (2F5.2)
 6042 FORMAT (5F5.2)
C  READ NEW FLEET MIX BUILDING FACTURS
      READ (ISYST,6043)
 6043 FORMAT (/)
      READ (ISYST,6044) ((ADDPCT(MC,LC),MC=1,6),LC=4,12)
 6044 FORMAT (6F6.2)
C  READ IN SHIP CARRYING CAPACITIES
      READ (ISYST,6043)
      IF (IS .NE. 1) READ (ISYST,6045) ((CC(MC,LC),LC=LUP,12),MC=1,6)
      IF (IS .EQ. 1) READ (ISYST,4045) ((CC(MC,LC),LC=LUP,12),MC=1,6)
 4045 FORMAT (2F7.0)
 6045 FORMAT (5F7.0)
C  READ IN LOCKING TIMES
      READ (ISYST,6043)
      READ (ISYST,6046) (((TMLOCK(LC,ND,J),LC=4,12),ND=1,2),J=1,2)
      READ (ISYST,6043)
      READ (ISYST,6046) (((TLTML2(LC,ND,J),LC=4,12),ND=1,2),J=1,2)
      READ (ISYST,6043)
      READ (ISYST,6046) (((TLTML3(LC,ND,J),LC=4,12),ND=1,2),J=1,2)
 6046 FORMAT (9F6.1)
C  LOCKING TIME STANDARD DEVIATION
      READ (ISYST,6043)
      READ (ISYST,6046) (((STDEV(LC,ND,J),LC=4,12),ND=1,2),J=1,2)
      IF (IS .NE. 1) GO TO 6074
      DO 6075 LC= 4,NEWLU
         DO 6076 ND= 1,2
            DO 6077 J= 3,4
               TMLOCK(LC,ND,J)= TMLOCK(LC,ND,2)
               TLTML2(LC,ND,J)= TLTML2(LC,ND,2)
               TLTML3(LC,ND,J)= TLTML3(LC,ND,2)
               STDEV(LC,ND,J)= STDEV(LC,ND,2)
 6077       CONTINUE
            IF (NEWLU .LE. 11) GO TO 6076
               TMLOCK(LC,ND,1)= 0.0
               TLTML2(LC,ND,1)= 0.0
               TLTML3(LC,ND,1)= 0.0
               STDEV(LC,ND,1)= 0.0
 6076    CONTINUE
 6075 CONTINUE
 6074 DO 8073 ND=1,2
         REDLT(IS,ND,NHOWTO)=REDLT(IS,ND,NHOWTO)/100.0
 8073 CONTINUE
      KX=2
      IF (IS .EQ. 1) KX=3
      IF (IS .EQ. 1 .AND. NEWLU .GE. 1) KX=4
      DO 8074 LC= 4,NEWLU
         DO 8075 ND= 1,2
            DO 8076 K= 1,KX
            TMLOCK(LC,ND,K)= TMLOCK(LC,ND,K)*(1.0-REDLT(IS,ND,NHOWTO))
            TLTML2(LC,ND,K)=TLTML2(LC,ND,K)*(1.0-REDLT(IS,ND,NHOWTO))
            TLTML3(LC,ND,K)=TLTML3(LC,ND,K)*(1.0-REDLT(IS,ND,NHOWTO))
 8076       CONTINUE
 8075    CONTINUE
 8074 CONTINUE
C  READ IN LOADING AND UNLOADING RATES
      READ (ISYST,6043)
      READ (ISYST,6047) ((FILL(MC,LC),MC=1,6),LC=LUP,12)
      READ (ISYST,6043)
      READ (ISYST,6047) ((EMPTY(MC,LC),MC=1,6),LC=LUP,12)
 6047 FORMAT (6F7.1)
C  READ IN VESSEL SPEED
      READ (ISYST,6043)
      IF (IS .EQ. 1) READ (ISYST,6048) ((VSA(MN,LC,1),MN=1,14),LC=
     +  LUP,12)
      IF (IS .NE. 1) READ (ISYST,6048) ((VSA(MN,LC,2),MN=1,14),LC=
     +  LUP,12)
 6048 FORMAT (14F5.2)
C  READ IN RETIREMENT PERCENTAGES
      READ (ISYST,6043)
      DO 6049 J= 1,9
         J1= J- 1
         IF (J1 .EQ. 0) IRR= 8
         IF (J1 .EQ. 1) IRR= 15
         IF (J1 .GE. 2) IRR= J1* 10
         IF (IS .NE. 1) READ (ISYST,6052) (PO(IRR,LC),LC=LUP,12)
         IF (IS .EQ. 1) READ (ISYST,4052) (PO(IRR,LC),LC=LUP,12)
 6049 CONTINUE
 6052 FORMAT (5F5.2)
 4052 FORMAT (2F5.2)
```

```
      DO 6053 LC= LUP,NEWLU
         DO 6054 J=10,14,2
            YEAR= J$ 1.0- 8.0
            PO(J,LC)= PO(8,LC)+(YEAR/7.0)$(PO(15,LC)-PO(8,LC))
 6054    CONTINUE
         DO 6055 J= 16,18,2
            YEAR= J$1.0-15.0
            PO(J,LC)= PO(15,LC)+(YEAR/5.0)$(PO(20,LC)-PO(15,LC))
 6055    CONTINUE
         DO 6056 J=2,7
            DO 6056 JJ= 2,8,2
               YEAR= JJ$1.0
               JYR= J$10+JJ
               J10= J$10
               J20= J$10+10
               PO(JYR,LC)= PO(J10,LC)+(YEAR/10.0)$(PO(J20,LC)-
     +           PO(J10,LC))
 6057       CONTINUE
 6056    CONTINUE
 6053 CONTINUE
C  READ IN CAPACITY INCREASE WITH DEPTH
      READ (ISYST,6045)
      IF (IS .NE. 1) READ (ISYST,6058) (CAPINC(LC),LC=LUP,12)
      IF (IS .EQ. 1) READ (ISYST,4058) (CAPINC(LC),LC=LUP,12)
 4058 FORMAT (2F7.2)
 6058 FORMAT (5F7.2)
      WRITE (8,7069)
      WRITE (8,6082)
 6082 FORMAT (31X,46H**** CAPACITY WAS INCREASED BY BUILDING LARGER,
     +  1X,10HLOCKS ****)
      IF (NEWLU .EQ. 11) WRITE (8,6083)
      IF (NEWLU .EQ. 12) WRITE (8,6084)
 6083 FORMAT (45X,29HMAXIMUM SHIP SIZE IS 1100X105)
 6084 FORMAT (45X,29HMAXIMUM SHIP SIZE IS 1200X130)
C
C  SET THE NEW BASE FLEET EQUAL TO THE FLEET FOR THE CAPACITY YEAR
C
      DO 6062 MC= 1,6
         DO 6063 LC= 4,LU
            BASEFT(MC,LC)= SHIP(LC,MC)
 6063    CONTINUE
         DO 6064 LC=LUP,NEWLU
            BASEFT(MC,LC)= 0.0
 6064    CONTINUE
 6062 CONTINUE
C
C
C  MAKE PROGRAMMING CHANGES CORRESPONDING TO THE NEW LOCKS
C
      DO 1519 LC=LUP,NEWLU
         BLOAD(LC)= 0.0
         GBAL(LC)= 0.0
         ZB(LC)= ZBHF(LC)
         IZBH(LC)= 100*ZB(LC)+0.5
 1519 CONTINUE
C  DIFFERENT LOCKS AT THE SOO
      IF (IS .EQ. 1 .AND. NEWLU .GE. 11) KU= 4
C  CHANGE NON-CONSTRAINING LOCK FACTORS
      IF (IS .EQ. 1) GO TO 6071
      IF (IS .EQ. 2) GO TO 6072
         CALFAC= 4.0
         SYSFAC= 4.0
         SYSTIM= 15.0
      GO TO 6071
 6072    CALFAC= 3.0
         SYSFAC= 3.0
         SYSADD= 0.0
         SYSTIM= 2.0
 6071 CONTINUE
      LU= NEWLU
      GO TO 130
 6050 GO TO 100
  130      IF(IR.EQ.15) GO TO 7500
  129        CONTINUE
  120        CONTINUE
  110    CONTINUE
  100 CONTINUE
C
C ***** END YEARLY LOOP *****
C ***** END SEASON EXTENSION LOOP *****
C ***** END LOCKING TIME LOOP *****
C ***** END SYSTEM LOOP *
C
      STOP
      END
C
```

```
      SUBROUTINE FLEET (INDEXC,IR,ISN,LU,IS,SYSFAC,SYSADD)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM FLEET CALCULATES THE ZERO-BACKHAUL FLEET
C  REQUIRED TO TRANSPORT THEPOTENTIAL CARGO TONNAGE
C
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON/QUECOM/CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITQ1(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
      COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
C
      DIMENSION ADDSHP(6,12),ALLSHP(6,12),ANCAP(6),CARGON(6),
     + DELSHP(6,12),FLEETR(6,12),SHPCAP(6,12),TIMELK(12),TRIPTM(6,12)
      DIMENSION CONSHA(6)
C
      ABTEST=.001
      DF=1.0
      DO 5 MC=1,6
         HRSYR(MC)=0.
         ANCAP(MC)=0.
         DO 3 LC=4,LU
            VSM(LC,MC)=0.
            ALLSHP(MC,LC)=0.
            ADDSHP(MC,LC)=0.
            DELSHP(MC,LC)=0.
    3    CONTINUE
    5 CONTINUE
C
C  PROHIBIT CERTAIN VESSELS FROM WINTER OPERATION
      DO 10 MN=1,14
         IF(MN.LE.3.AND.ISN.GE.2)VSA(MN,4,ISN)=0.
         IF( MN.LE.3 .AND. ISN.GE.2 )VSA(MN,5,ISN)=0.
         IF(IS.NE.1.AND.MN.LE.4.AND.ISN.GE.2)VSA(MN,4,ISN)=0.
         IF( IS.NE.1.AND.MN.LE.4.AND.ISN.GE.2 )VSA(MN,5,ISN)=0.
         IF(IS.NE.1.AND.MN.EQ.14.AND.ISN.GE.2)VSA(MN,4,ISN)=0.
         IF( IS.NE.1.AND.MN.EQ.14.AND.ISN.GE.2 )VSA(MN,5,ISN)=0.
C
C  CALCULATE THE OPERATING HOURS PER YEAR
         DO 8 MC=1,6
            HRSYR(MC)=HRSYR(MC)+HRS(MN,ISN,MC)
    8    CONTINUE
   10 CONTINUE
      DO 30 LC=4,LU
C
C  CALCULATE THE MEAN VESSEL SPEED
         DO 20 MN=1,14
            DO 15 MC=1,6
              IF (VSA(MN,LC,ISN).LE.00.0) VSA(MN,LC,ISN)=0.
              VSM(LC,MC)=VSA(MN,LC,ISN)*HRS(MN,ISN,MC)/HRSYR(MC)
     +         +VSM(LC,MC)
   15       CONTINUE
   20    CONTINUE
C
C  CALCULATE THE TIME SPENT IN THE LOCKS
         IF(IS.EQ.1.AND.LC.GE.8)J=3
         IF(IS.EQ.1.AND.LC.LE.7)J=1
         IF(IS.EQ.1)TIMELK(LC)=(TMLOCK(LC,1,J)+TMLOCK(LC,2,J))/60.
         IF(IS.EQ.2)TIMELK(LC)=(TMLOCK(LC,1,1)+TMLOCK(LC,2,1)+SYSFAC
     +    *(TMLOCK(LC,1,2)+TMLOCK(LC,2,2)))/60.+SYSADD
         IF(IS.EQ.3)TIMELK(LC)=(TMLOCK(LC,1,1)+TMLOCK(LC,2,1)+SYSFAC
     +    *(TMLOCK(LC,1,2)+TMLOCK(LC,2,2)))/60
   30 CONTINUE
```

```
      DO 50 MC=1,6
         IF(INDEXC.EQ.0)CARGOP(MC,1,IR)=1000.*
     +      CARGOP(MC,1,IR)
         IF(INDEXC.EQ.0)CARGOP(MC,2,IR)=1000.*
     +      CARGOP(MC,2,IR)
         TCARG=CARGOP(MC,1,IR)+CARGOP(MC,2,IR)
         IF (ABS(TCARG).LE.ABTEST) WDIST(MC)=0
         IF (ABS(TCARG).LE.ABTEST) GO TO 40
            WDIST(MC)=(CARGOP(MC,1,IR)*DISTN(1,MC)+CARGOP(MC,2,
     +       IR)*DISTN(2,MC))/TCARG
   40    CONTINUE
C
C  PHASE OUT OLD SHIPS
         DO 90 LC=4,LU
            FLEETR(MC,LC)=BASEFT(MC,LC)*(1.0-PO(IR,LC))
C
C  CALCULATE THE TIME PER ROUND TRIP
            TRIPTM(MC,LC)=DF*(2.0*WDIST(MC)/VSM(LC,MC)+CC(MC,LC)*
     +       FLOAD(MC)/EMPTY(MC,LC)+FLOAD(MC)*CC(MC,LC)/
     +       FILL(MC,LC))+TIMELK(LC)
            IF (ABS(WDIST(MC)).LE.ABTEST)TRIPYR(MC,LC)=0
            IF (ABS(WDIST(MC)).LE.ABTEST.OR.ABS(TRIPTM(MC,LC))
     +       .LE.ABTEST)GO TO 80
C
C  CALCULATE THE NUMBER OF ROUND TRIPS PER YEAR PER VESSEL
              TRIPYR(MC,LC)=HRSYR(MC)/TRIPTM(MC,LC)
   80       CONTINUE
C
C  CALCULATE THE REMAINING FLEET TRANSPORT CAPACITY
C
            SHPCAP(MC,LC)=FLEETR(MC,LC)*TRIPYR(MC,LC)*CC(MC,LC)*
     +       FLOAD(MC)
            ANCAP(MC)=ANCAP(MC)+SHPCAP(MC,LC)
   90    CONTINUE
         CARGON(MC)=CARGOP(MC,1,IR)+CARGOP(MC,2,IR)-
     +      ANCAP(MC)
         IF(ABS(CARGON(MC)).LE.ABTEST) GO TO 599
            IF(CARGON(MC).LT.0.0) GO TO 299
C
C  BUILD SHIPS TO MEET THE CARGO DEMAND
C
C   DETERMINE THE COMPOSITE SHIP TO BE ADDED
      COMSHA(MC)= 0.0
      DO 7600 LC= 4,LU
         COMSHA(MC)= COMSHA(MC)+ ADDPCT(MC,LC)* TRIPYR(MC,LC)*
     +      CC(MC,LC)*FLOAD(MC)
 7600 CONTINUE
C   DETERMINE THE NUMBER OF SHIPS TO BE ADDED
      DO 7610 LC= 4,LU
         ADDSHP(MC,LC)= (CARGON(MC)/COMSHA(MC))* ADDPCT(MC,LC)
C
C   CALCULATE THE NEW FLEET MIX
C
         FLEETN(MC,LC)= FLEETR(MC,LC)+ ADDSHP(MC,LC)
 7610 CONTINUE
      GO TO 499
C
C  DELETE SHIPS IF NECESSARY
C
  299    DO 190 IC= 4,LU
           LC= IC
           IF (ABS(TRIPYR(MC,LC)) .LE. ABTEST) DELSHP(MC,LC)= 0.0
           IF (ABS(TRIPYR(MC,LC)) .LE. ABTEST) GO TO 190
              DELSHP(MC,LC)= -CARGON(MC)/(CC(MC,LC)*FLOAD(MC)*
     +          TRIPYR(MC,LC))
              IF (IS .NE. 1 .AND. MC .GE. 5) GO TO 399
              IF (DELSHP(MC,LC) .LE. FLEETR(MC,LC)) GO TO 399
                 DELSHP(MC,LC)= FLEETR(MC,LC)
                 CARGON(MC)= CARGON(MC)+ DELSHP(MC,LC)*
     +             FLOAD(MC)*CC(MC,LC)*TRIPYR(MC,LC)
  190    CONTINUE
  399    CONTINUE
C
C  CALCULATE THE NEW FLEET
           DO 200 LC= 4,LU
              FLEETN(MC,LC)= (FLEETR(MC,LC)-DELSHP(MC,LC))
  200      CONTINUE
  499    CONTINUE
  599 CONTINUE
   50 CONTINUE
                              DO 78 LC=3,LU
                                 TLOADT(LC)=0.
                                 TBALT(LC)=0.
                                 DO 27 MC=1,6
                                    DO 26 ND=1,2
                                       ICTRNP(MC,LC,ND)=0
   26                                 CONTINUE
   27                              CONTINUE
   78                           CONTINUE
      RETURN
      END
```

AD-A111 247 BOOZ-ALLEN AND HAMILTON INC BETHESDA MD F/G 15/5
GREAT LAKES/ST. LAWRENCE SEAWAY REGIONAL TRANSPORTATION STUDY: --ETC(U)
MAY 81 M R HORNE, A P FREE DACW35-80-C-0060
UNCLASSIFIED 719C-7 NL



```
      SUBROUTINE LTRAN(IR,ISN,LU,MN,IS,INDEXC,YESTRN,TDFCX)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM LTRAN CALCULATES THE TOTAL NUMBER OF ANNUAL
C  LOADED TRANSITS AND DISTRIBUTES THE TRANSITS OVER THE OPERATING YEAR
C
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
C
      DIMENSION CDBC(6,12),ENDFAC(6,12),TDFT(6,12),TDFC(12,14),
     + CARGT(12,2)
C
      LOGICAL YESTRN
      DIMENSION TDFCX(5,4)
C
      ABTEST=.001
      DO 1 LC=4,LU
         DO 15 ND=1,2
            CARGT(LC,ND)=0
   15    CONTINUE
         DO 3 MC=1,6
            DO 9 ND=1,2
               ADDTRN(MC,LC,ND)=0
               CTRNPM(MC,LC,ND)=0
    9       CONTINUE
            IF( MN.EQ.4 ) TDFT(MC,LC)=0
    3    CONTINUE
    1 CONTINUE
      DO 648 ND=1,2
         DO 647 MC=1,6
            EXTPT(MC,ND,IR)=0
  647    CONTINUE
  648 CONTINUE
C
C  PROHIBIT CERTAIN VESSELS FROM WINTER OPERATION
      IF(MN.LE.3.AND.ISN.GE.2) VSA(MN,4,ISN)=0
      IF(MN.LE.3.AND.ISN.GE.2) VSA(MN,5,ISN)=0
      IF(IS.NE.1.AND.MN.LE.4.AND.ISN.GE.2) VSA(MN,4,ISN)=0.
      IF(IS.NE.1.AND.MN.LE.4.AND.ISN.GE.2) VSA(MN,5,ISN)=0.
      IF(IS.NE.1.AND.MN.EQ.14.AND.ISN.GE.2) VSA(MN,4,ISN)=0.
      IF(IS.NE.1.AND.MN.EQ.14.AND.ISN.GE.2) VSA(MN,5,ISN)=0.
C
C  BYPASS DISTRIBUTION IN THE NEW FLEET FOR
C  EXTENDED SEASON GRAIN AND GENERAL CARGO
      DO 30 MC=1,6
         IF(MC.EQ.4.AND.ISN.GT.1.AND.MN.LE.3)GO TO 70
         IF(MC.EQ.6.AND.ISN.GT.1.AND.MN.LE.3)GO TO 70
         DO 20 LC=4,LU
            TCARG=(CARGOP(MC,1,IR)+CARGOP(MC,2,IR))
C
C  CALCULATE THE TRANSIT DISTRIBUTION FACTORS
C  ACCORDING TO FLEET ABILITIES
            TDFC(LC,MN)=HRS(MN,ISN,MC)*VSA(MN,LC,ISN)/(HRSYR(MC)*
     +       VSM(LC,MC))
            IF (ISN .EQ. 1 .AND. INDEXC .EQ. 0)
     +       TDFI=TDFC(LC,MN)*DFA(MN,ISN)
            IF(ISN.GT.1.AND.INDEXC.EQ.0)TDFI=TDFC(LC,MN)*DFA(MN,ISN)
C
C  INCORPORATE CARGO SHIPPING DEMAND
            IF (ISN .EQ. 1 .AND. INDEXC .GT. 0)
     +       TDFC(LC,MN)=TDFC(LC,MN)*DFA(MN,ISN)*
     +       ENDFAC(MC,LC)
            IF(ISN.GT.1.AND.INDEXC.GT.0)TDFC(LC,MN)=
     +       TDFC(LC,MN)*DFA(MN,ISN)*ENDFAC(MC,LC)
            IF(ABS(TCARG).LE.ABTEST) CDBC(MC,LC)=0.0
            IF (ABS(TCARG).LE.ABTEST) GO TO 7
C  CALCULATE THE CARGO DISTRIBUTION BY CLASS
            CDBC(MC,LC)=FLEETN(MC,LC)*FLOAD(MC)*CC(MC,LC)*TRIPYR(
     +       MC,LC)/TCARG
    7       CONTINUE
            DO 10 ND=1,2
C
C  CALCULATE THE ANNUAL LOADED TRANSITS
               CTRAN(MC,LC,ND)=(CARGOP(MC,ND,IR))*CDBC(MC,LC)/
     +          (FLOAD(MC)*CC(MC,LC))
C
```

```
C  CALCULATE THE -MONTHLY- LOADED TRANSITS
                CTRNPM(MC,LC,ND)=CTRAN(MC,LC,ND)*TDFC(LC,MN)
                CARGT(LC,ND)=CARGT(LC,ND)+CTRAN(MC,LC,ND)
   10         CONTINUE
              IF(INDEXC.EQ.0) TDFT(MC,LC)=TDFT(MC,LC)+TDFI
              IF(MN.EQ.3.AND.INDEXC.EQ.0)ENDFAC(MC,LC)=1.0/TDFT(MC,LC)
              MM=14
              IF( (MC.EQ.4.OR.MC.EQ.6).AND.MN.EQ.MM.AND.INDEXC.EQ.
     +            0 )ENDFAC(MC,LC)=1.0/TDFT(MC,LC)
   20       CONTINUE
   70       CONTINUE
            YESTRN=.FALSE.
C
C  CALCULATE THE TOTAL TRANSITS PER OPERATING PERIOD
           DO 55 LC=4,LU
              DO 35 ND=1,2
                 CTRNPM(MC,LC,ND)=CTRNPM(MC,LC,ND)+ADDTRN(MC,LC,ND)
                 IF( CTRNPM(MC,LC,ND).GT.0.0 ) YESTRN=.TRUE.
   35         CONTINUE
   55      CONTINUE
    30 CONTINUE
C
       RETURN
       END
C
C ***************************************************************************
C
       SUBROUTINE TFRCT(LU,MC,MN,ABTEST,IR,ISN,BTF4,BTF5,
      + BTF13,BTF14)
C
       IMPLICIT INTEGER (I)
C
C
C  THE TRANSIT FORECAST MODULE DETERMINES THE NUMBER OF DAILY LOADED
C  AND BALLASTED TRANSITS, AND INCLUDES PLEASURE CRAFT AND ICE LOCKAGES
C
       COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
      + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
      + TMLOCK(12,2,4),VSA(14,12,4)
       COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
      + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
      + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
      + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
       COMMON /PRELIM/ IIT(3),ISES(4),ILTM(3)
       COMMON /DAT1/ BTF(14,4),CAREX1(6,2,80),CAREX2(6,2,80),
      + DATM(14),DIN(14,4),DIST(6),
      + EXTP1(6,2,80),EXTP2(6,2,80),
      + IZBH(12),LYEAR(80),ODAYS(12),PCRF(14,2),SCOST(12),STDEV(12,2,4),
      + TLTML2(12,2,4),TLTML3(12,2,4),TURNBK(4),UNLOAD(12),XCAP(12),
      + XSHIP(12),ZB(12),GBAL(12),GLOAD(12)
       COMMON/QUECOM/CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
      + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
      + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
      + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
      + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
      + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
       COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
      + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
      + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
      + SABAR(12,2),SDEV(4,2),SHIP(12,6),SQQAR(4,12,2),TBAL(14,12),
      + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
      + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
      + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
C
           TOTAL=0
           DO 59 LC=4,LU
              IF( MN.EQ.4 ) TLOADT(LC)=0
              IF( MN.EQ.4 )TBALT(LC)=0
              DO 47 ND=1,2
                 TCTR=0.
                 TLOAD(MN,LC)=0
                 TBAL(MN,LC)=0
                 DO 48 MC=1,6
                    TCTR=TCTR+CTRNPM(MC,LC,ND)
   48            CONTINUE
                 DLTRN(LC,ND,MN)=TCTR/DM(MN)
   47         CONTINUE
              ZBHF(LC)=ZB(LC)
C
C  BALLAST TRANSIT CALCULATIONS
           EMPTY2=DLTRN(LC,1,MN)-DLTRN(LC,2,MN)
           IF( ABS(DLTRN(LC,1,MN)).LE.ABTEST .OR. ABS(DLTRN(LC,2,
     +     MN)).LE.ABTEST ) ZBHF(LC)=0
```

```
          IF( EMPTY2.GE.0.0 )GOTO 731
             DBTRN(LC,1,MN)=-EMPTY2+(DLTRN(LC,2,MN)
     +        +EMPTY2)*(1.0-ZBHF(LC))
             DBTRN(LC,2,MN)=(DLTRN(LC,2,MN)+EMPTY2)
     +        *(1.0-ZBHF(LC))
             GOTO 732
  731     CONTINUE
             DBTRN(LC,2,MN)=EMPTY2+(DLTRN(LC,1,MN)-
     +        EMPTY2)*(1.0-ZBHF(LC))
             DBTRN(LC,1,MN)=(DLTRN(LC,1,MN)-EMPTY2)
     +        *(1.0-ZBHF(LC))
  732     CONTINUE
          IF( IR.NE.1.OR.ISN.NE.1 ) GOTO 733
C
C  INCORPORATE TRAFFIC BIAS
             IF( MN.EQ.4 )DBTRN(LC,2,MN)=DBTRN(LC,2,MN)*(1.0+BTF4)
             IF( MN.EQ.5 )DBTRN(LC,2,MN)=DBTRN(LC,2,MN)*(1.0+BTF5)
             IF( MN.EQ.13 )DBTRN(LC,2,MN)=DBTRN(LC,2,MN)*(1.0-BTF13)
             IF( MN.EQ.14 )DBTRN(LC,2,MN)=DBTRN(LC,2,MN)*(1.0-BTF14)
             GOTO 734
  733     CONTINUE
             IF(MN.GE.4.AND.MN.LT.13)DBTRN(LC,2,MN)=
     +        DBTRN(LC,2,MN)*(1.0+BTF(MN,ISN))
             IF((MN.LT.4.OR.MN.GT.12))DBTRN(LC,2,MN)=
     +        DBTRN(LC,2,MN)*(1.0-BTF(MN,ISN))
  734     CONTINUE
   59 CONTINUE
C
C  INCLUDE PLEASURE CRAFT AND ICE LOCKAGES
       DO 50 ND=1,2
          DBTRN(3,ND,MN)=PCRF(MN,ND)
          DLTRN(3,ND,MN)=0
          DO 49 LC=3,LU
             TOTAL=TOTAL+DLTRN(LC,ND,MN)+DBTRN(LC,ND,MN)
   49     CONTINUE
   50  CONTINUE
       DO 55 LC=4,LU
          TLOAD(MN,LC)=TLOAD(MN,LC)+DLTRN(LC,1,MN)+DLTRN(LC,2,MN)
          TBAL(MN,LC)=TBAL(MN,LC)+DBTRN(LC,1,MN)+DBTRN(LC,2,MN)
          TLOADT(LC)=TLOADT(LC)+TLOAD(MN,LC)*DM(MN)
          TBALT(LC)=TBALT(LC)+TBAL(MN,LC)*DM(MN)
          IF(MN.NE.3)GO TO 737
             GLOAD(LC)=TLOADT(LC)
             GBAL(LC)=TBALT(LC)
             IF(ABS(GLOAD(LC)).LE.ABTEST)REDFT(LC)=1.0
             IF(ABS(GLOAD(LC)).LE.ABTEST)GO TO 92
C
C  CALCULATE THE FLEET REDUCTION FACTOR AND THE ACTUAL FLEET
                REDFT(LC)=GBAL(LC)/(GBAL(LC)+GLOAD(LC))+0.5
   92        CONTINUE
             DO 58 MC=1,6
                SHIP(LC,MC)=FLEETN(MC,LC)*REDFT(LC)
   58        CONTINUE
  737     CONTINUE
   55 CONTINUE
C
       RETURN
       END
C
C ********************************************************************
C
       SUBROUTINE DISPCH(MN,LU,IS,ISW,JCT,KHOPOE,DATM)
C
       IMPLICIT INTEGER (I)
C
C
C  THE SHIP DISPATCH MODULE DISPATCHES SHIPS TO THE 4 SOO LOCKS
C
       COMMON/QUECOM/CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
       COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
       DIMENSION CL(4,2),ROE(4,2),ARDIF(3,2),RPLCL(3,2),DATM(14),
     +  TRNBL(4,12,2),TRNLD(4,12,2),TRANSB(4,12,2),TRANSL(4,12,2)
C
       IF (LU .GE. 11) GO TO 8201
C
C  DISTRIBUTE SHIPS BETWEEN THE POE AND MACARTHUR LOCKS
```

```
      DO 120 ND=1,2
         ARTCL(ND)=DLTRN(7,ND,MN)+DLTRN(6,ND,MN)+DLTRN(5,ND,MN)
         POECL(ND)=DLTRN(8,ND,MN)+DLTRN(9,ND,MN)+DLTRN(10,ND,MN)
     +    +DLTRN(11,ND,MN)+DBTRN(9,ND,MN)+DBTRN(10,ND,MN)+
     +    DBTRN(11,ND,MN)
         IF( TLOCKM(2,ND).EQ.0 ) TLOCKM(2,ND)=0.0000001
         IF( TLOCKM(3,ND).EQ.0 ) TLOCKM(3,ND)=0.0000001
         ARTPOE(ND)=(ARTCL(ND)*TLOCKM(2,ND)-POECL(ND)*TLOCKM(3,ND))/
     +    (TLOCKM(3,ND)+TLOCKM(2,ND))
         IF(ARTPOE(ND).LE.0.)ARTPOE(ND)=0.
         RPMCL(ND)=0.
         IF(ARTCL(ND).GT.0.)RPMCL(ND)=ARTPOE(ND)/ARTCL(ND)
         IF(ISW.EQ.1.AND.JCT.NE.0) RPMCL(1)=RPMCL(1)-0.1
         IF(IS.EQ.1.AND.RHO(2,1).GE.RHOPOE) RPMCL(ND)=0.
         IF(RPMCL(ND).LE.0.) RPMCL(ND)=0.
C
C  COMPUTE THE SABIN AND DAVIS LOCK ARRIVALS
C  COMPUTE MACARTHUR LOCK ARRIVALS
C  COMPUTE POE LOCK ARRIVALS
C
         DO 140 LC=3,LU
            SABAR(LC,ND)=UBTRN(LC,ND,MN)
            IF(LC.EQ.4)SABAR(4,ND)=DBTRN(4,ND,MN)+DLTRN(4,ND,MN)
            IF(LC.GT.8)SABAR(LC,ND)=0
C
            ARTAR(LC,ND)=DLTRN(LC,ND,MN)*(1.-RPMCL(ND))
            IF(LC.EQ.3)ARTAR(LC,ND)=DBTRN(3,ND,MN)
            IF(LC.EQ.4)ARTAR(LC,ND)=0.
            IF(LC.GT.7)ARTAR(LC,ND)=0.
C
            POEAR(LC,ND)=DLTRN(LC,ND,MN)+DBTRN(LC,ND,MN)
            IF( LC.EQ.8 ) POEAR(LC,ND) = DLTRN(LC,ND,MN)
            IF( LC.EQ.4 )POEAR(LC,ND)=0.
            IF(RPMCL(ND).LE.0.)RPMCL(ND)=0.
            IF(LC.LT.8.AND.LC.GT.4)POEAR(LC,ND)=DLTRN(LC,ND,MN)*
     +       RPMCL(ND)
  140    CONTINUE
  120 CONTINUE
      IF(LU.LE.10) GO TO 8226
C
C  ALLOCATE SHIPS THROUGH THE EXPANDED SOO LOCKS
C
 8201 CONTINUE
      ILOCK= 1
      IF (LU .GE. 12) ILOCK= 2
      DO 8202 ND= 1,2
         DO 8204 I= 1,4
            DO 8216 LC= 4,LU
               TRNLD(I,LC,ND)= 0.0
               TRNBL(I,LC,ND)= 0.0
 8216       CONTINUE
 8204    CONTINUE
         DO 8214 LC= 4,LU
            IF (LC .EQ. 4) TRNLD(1,LC,ND)= DLTRN(LC,ND,MN)
            IF (LC .LE. 8) TRNBL(1,LC,ND)= DBTRN(LC,ND,MN)
            IF (LC .GE. 5 .AND. LC.LE.7)TRNLD(2,LC,ND)=DLTRN(LC,ND,MN)
            IF (LU .GE. 12 .AND. LC .EQ. 8)TRNBL(3,LC,ND)=TRNBL(1,LC,ND)
            IF (LU .GE. 12 .AND. LC .EQ. 4)TRNLD(2,LC,ND)=TRNLD(1,LC,ND)
            IF (LU .GE. 12 .AND. LC .LE. 7)TRNBL(2,LC,ND)=TRNBL(1,LC,ND)
            IF (LU .GE. 12) TRNBL(1,LC,ND)= 0.0
            IF (LU .GE. 12) TRNLD(1,LC,ND)= 0.0
            IF (LC .GE. 8.AND. LC .LE.10)TRNLD(3,LC,ND)= DLTRN(LC,ND,MN)
            IF (LC .GE. 9 .AND. LC .LE.10)TRNBL(3,LC,ND)=DBTRN(LC,ND,MN)
            IF (LC .GT. 10) TRNBL(4,LC,ND)= DBTRN(LC,ND,MN)
            IF (LC .GT. 10) TRNLD(4,LC,ND)= DLTRN(LC,ND,MN)
 8214    CONTINUE
 8219    DO 8217 LKS= ILOCK,4
            CL(LKS,ND)= 0.0
 8217    CONTINUE
         DO 8218 LKS= ILOCK,4
            DO 8221 LC= 4,LU
               CL(LKS,ND)= CL(LKS,ND)+TRNLD(LKS,LC,ND)+TRNBL(LKS,LC,ND)
 8221       CONTINUE
 8218    CONTINUE
C  CALCULATE LOCK UTILIZATIONS
         DO 8205 INDVLK= ILOCK,4
            ROE(INDVLK,ND)= CL(INDVLK,ND)*TLOCKM(INDVLK,ND)/(DATM(MN)
     +       *60.0)
 8205    CONTINUE
         NROE= 0
         DO 8206 INDVLK= ILOCK,3
            IND= INDVLK+1
            DIFROE= ABS(ROE(INDVLK,ND)-ROE(IND,ND))
            IF (DIFROE .GT. 0.005) NROE= 1
```

```
 8206    CONTINUE
         IF (NROE .EQ. 0) GO TO 8207
C  IF THE LOCK UTILIZATIONS ARE NOT EQUAL CALCULATE THE WEIGHTED
C  ARRIVAL DIFFERENCES
         DO 8208 LKDIF= ILOCK,3
            IND= LKDIF+1
            ARDIF(LKDIF,ND)= (CL(LKDIF,ND)*TLOCKM(LKDIF,ND)-CL(IND,ND)
     +        *TLOCKM(IND,ND))/(TLOCKM(LKDIF,ND)+TLOCKM(IND,ND))
            IF (ARDIF(LKDIF,ND) .LE. 0.0) ARDIF(LKDIF,ND)= 0.0
C  CALCULATE THE REPLACEMENT FRACTION
            RPLCL(LKDIF,ND)= ARDIF(LKDIF,ND)/CL(LKDIF,ND)
 8208    CONTINUE
C  CHECK TO SEE IF MAXIMUM REPLACEMENT HAS OCCURED
         MAXRP= 0
         DO 8209 LKDIF= ILOCK,3
           IF (RPLCL(LKDIF,ND) .GE. 0.005) MAXRP= 1
 8209    CONTINUE
         IF (MAXRP .EQ. 0) GO TO 8207
C  RE-ALLOCATE SHIPS TO EQUALIZE LOCK UTILIZATION
         DO 8222 LC= 4,LU
            DO 8223 LKS= ILOCK,3
               TRANSL(LKS,LC,ND)= TRNLD(LKS,LC,ND)*RPLCL(LKS,ND)
               TRANSB(LKS,LC,ND)= TRNBL(LKS,LC,ND)*RPLCL(LKS,ND)
               TRNLD(LKS,LC,ND)= TRNLD(LKS,LC,ND)-TRANSL(LKS,LC,ND)
               TRNBL(LKS,LC,ND)= TRNBL(LKS,LC,ND)-TRANSB(LKS,LC,ND)
 8223       CONTINUE
            DO 8224 LKS= ILOCK,3
               LKS1= LKS+1
               TRNLD(LKS1,LC,ND)=TRNLD(LKS1,LC,ND)+TRANSL(LKS,LC,ND)
               TRNBL(LKS1,LC,ND)=TRNBL(LKS1,LC,ND)+TRANSB(LKS,LC,ND)
 8224       CONTINUE
 8222    CONTINUE
         GO TO 8219
C
C  COMPUTE THE LOCK ARRIVALS
C
C
C  SABIN LOCK (IF MAXIMUM SHIP CLASS EQUALS 11)
C  MACARTHUR LOCK
C  POE LOCK
C  NEW DAVIS LOCK
C
 8207    CONTINUE
         TRNBL(1,8,ND)= TRNBL(1,8,ND)+TRNBL(2,8,ND)
         TRNBL(2,8,ND)= 0.0
         DO 8225 LC= 4,LU
            SABAR(LC,ND)= TRNBL(1,LC,ND)+TRNLD(1,LC,ND)
            ARTAR(LC,ND)= TRNBL(2,LC,ND)+TRNLD(2,LC,ND)
            POEAR(LC,ND)= TRNBL(3,LC,ND)+TRNLD(3,LC,ND)
            DAVAR(LC,ND)= TRNBL(4,LC,ND)+TRNLD(4,LC,ND)
 8225    CONTINUE
         ARTAR(3,ND)= DBTRN(3,ND,MN)
 8202 CONTINUE
 8226 CONTINUE
C
      RETURN
      END
C
C ***************************************************************
C
      SUBROUTINE CYCLTM(LK,LU,IS,MN,RHOCAP,RHOMAX,RHOPOE,TMCY,VARTNB)
C
      IMPLICIT INTEGER (I)
C
C
C  THE LOCK CYCLE TIME MODULE CALCULATES THE MEAN LUCK CYCLE TIME
C  AND ITS VARIANCE
C
      COMMON /CALCOM/ AUDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /DAT1/ BTF(14,4),CAREX1(6,2,80),CAREX2(6,2,80),
     + DATM(14),DIN(14,4),DIST(6),
     + EXTP1(6,2,80),EXTP2(6,2,80),
     + IZBM(12),LYEAR(80),ODAYS(12),PCRF(14,2),SCOST(12),STDEV(12,2,4),
     + TLTML2(12,2,4),TLTML3(12,2,4),TURNBK(4),UNLOAD(12),XCAP(12),
     + XSHIP(12),ZB(12),GBAL(12),GLOAD(12)
      COMMON/QUECOM/CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
```

```
      COMMON/D/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDECX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
C
         DO 210 ND=1,2
            DTLOCK(LK,ND)=0
            DO 190 LC=3,LU
               IF( IS.NE.1)GO TO 174
            IF (LU .LE. 11 .AND. LK .NE. 1) GO TO 174
            IF (LU .GE. 12 .AND. LK .NE. 2) GO TO 174
               IF (LU .GE. 11) GO TO 1174
                  SOOAR(1,LC,ND)=ARTAR(LC,ND)
                  SOOAR(2,LC,ND)=POEAR(LC,ND)
                  SOOAR(3,LC,ND)= SABAR(LC,ND)
            GO TO 174
 1174       IF (LU .EQ. 11) SOOAR(1,LC,ND)= SABAR(LC,ND)
             IF (LU .GE. 12) SOOAR(1,LC,ND)= 0.0
            SOOAR(2,LC,ND)= ARTAR(LC,ND)
            SOOAR(3,LC,ND)= POEAR(LC,ND)
            SOOAR(4,LC,ND)= DAVAR(LC,ND)
  174          CONTINUE
               IF( IS.EQ.1 .OR. LK.EQ.2 )GO TO 175
                  SOOAR(1,LC,ND)=ULTRN(LC,ND,MN)+DBTRN(LC,ND,MN)
                  SOOAR(2,LC,ND)=SOOAR(1,LC,ND)
  175          CONTINUE
               DTLOCK(LK,ND)=DTLOCK(LK,ND)+SOOAR(LK,LC,ND)
  190       CONTINUE
C
C  CALCULATE THE VESSEL ARRIVAL RATE
            RAMDA(LK,ND)=DTLOCK(LK,ND)/(DATM(MN)*60.)
            TMEAN(LK,ND)=0
            TVAR=0.
            IF(DTLOCK(LK,ND).LE.0.)GO TO 735
               J=1
               IF(IS.NE.1)J=LK
               IF(IS.EQ.1.AND.LK.LE.2)J=2
               IF (IS .EQ. 1 .AND. LU .GE. 11) J= LK
C
C  CALCULATE THE ONE WAY MEAN LOCKING TIME AND ITS VARIANCE
               DO 220 LC=3,LU
                  TMLOCK(3,ND,J)=TMLOCK(4,ND,J)
                  STDEV(3,ND,J)=STDEV(4,ND,J)
                  TMLK=SOOAR(LK,LC,ND)*TIMES(MN)*TMLOCK(LC,ND,J)/
     +             DTLOCK(LK,ND)
                  TMEAN(LK,ND)=TMEAN(LK,ND)+TMLK
                  VAR=SOOAR(LK,LC,ND)*STDEV(LC,ND,J)**2/DTLOCK(
     +             LK,ND)
                  TVAR=TVAR+VAR
  220          CONTINUE
               TURN=0.
               DO 212 LC=3,LU
                  VRN=(TMLOCK(LC,ND,J)-TMEAN(LK,ND))**2*SOOAR(LK,
     +             LC,ND)/DTLOCK(LK,ND)
                  TURN=TURN+VRN
  212          CONTINUE
               AVGVAR(LK,ND)=TURN+TVAR
  735       CONTINUE
  210    CONTINUE
C
C CALCULATE THE HEAVY BALANCED LOCK CYCLE TIME
         HBLCT=TMEAN(LK,1)+TMEAN(LK,2)
         DO 240 ND=1,2
            RHOCAP=RHOMAX
            IF(IS.EQ.1.AND.LK.EQ.2) RHOCAP=RHOPOE
            IF(ND.EQ.1)NI=2
            IF(ND.EQ.2)NI=1
            IF(DTLOCK(LK,ND).LE.0.)GO TO 230
               TMCY=TMEAN (LK,ND)+TURNBK(LK)-(TMEAN(LK,NI)
     +          +TURNBK(LK))*(RAMDA(LK,NI)*TURNBK(LK)-RAMDA(LK,
     +          NI)*TMEAN(LK,NI))
               TMCYCL(LK,ND)=TMCY/(1.-(RAMDA(LK,NI)*TURNBK(LK)-
     +          RAMDA(LK,NI)*TMEAN(LK,ND))*(RAMDA(LK,ND)*TURNBK(
     +          LK)-RAMDA(LK,ND)*TMEAN(LK,ND)))
               IF(TMCYCL(LK,ND).GT.HBLCT) TMCYCL(LK,ND)=HBLCT
               CAPCTY(LK,ND)=60.*RHOCAP*DATM(MN)/HBLCT
C
C  CALCULATE LOCK UTILIZATION
               RHO(LK,ND)=RAMDA(LK,ND)*TMCYCL(LK,ND)
```

```
C  IF NECESSARY, BRING DAVIS LOCK INTO OPERATION
                IF (IS .EQ. 1 .AND. LU .GE. 11) GO TO 231
                IF(LK.EQ.3.AND.RHO(LK,ND).GT.0.7)RAMDA(LK,ND)=
     +           RAMDA(LK,ND)/2.
                IF(LK.EQ.3.AND.RHO(LK,ND).GT.0.7)RHO(LK,ND)=
     +           RHO(LK,ND)/2.
  231           CONTINUE
                CUTF(LK,ND)=1.0
C
C  IF CAPACITY IS REACHED, CUT OFF TRANSITS
                IF(RHO(LK,ND).LT.RHOCAP)GO TO 230
                   CUTF(LK,ND)=RHOCAP/RHO(LK,ND)
                   RAMDA(LK,ND)=RHOCAP/TMCYCL(LK,ND)
                   RHO(LK,ND)=RAMDA(LK,ND)*TMCYCL(LK,ND)
  230           CONTINUE
  240        CONTINUE
             IF(DTLOCK(LK,1).LE.0.OR.DTLOCK(LK,2).LE.0)GO TO 234
C
C  CALCULATE THE VARIANCE IN THE LOCK CYCLE TIME
             VARTM(LK,1)=AVGVAR(LK,1)+(1-RHO(LK,2))**2.0
     +       *VARTMB+RHO(LK,2)**2*AVGVAR(LK,2)
             SDEV(LK,1)=VARTM(LK,1)**0.5
             VARTM(LK,2)=AVGVAR(LK,2)+(1-RHO(LK,1))**2.0
     +        *VARTMB+RHO(LK,1)**2*AVGVAR(LK,1)
             SDEV(LK,2)=VARTM(LK,2)**0.5
  234        CONTINUE
C
           RETURN
           END
C
C ************************************************************
C
           SUBROUTINE QUEMOD(LK,MN,IS,CALFAC,LU)
C
           IMPLICIT INTEGER (I)
C
C
C  THE QUEUEING MODULE CALCULATES  THE QUEUE LENGTH AND THE WAITING TIME
C
           COMMON/QUECOM/CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
          + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
          + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
          + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
          + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
          + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
           COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
          + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
          + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
          + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
          + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
          + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
          + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
C
           DO 242 ND=1,2
              IF(DTLOCK(LK,1).LE.0.OR.DTLOCK(LK,2).LE.0)GO TO 235
                 WTQ=(RAMDA(LK,ND)**2*VARTM(LK,ND))+RHO(LK,ND)**2
                 WTQM(LK,ND,MN)=WTQ/(RAMDA(LK,ND)*2.*(1.0-RHO(LK,ND)))
                 QUE(LK,ND,MN)=WTQM(LK,ND,MN)*RAMDA(LK,ND)
                 WTQM(LK,ND,MN)=WTQM(LK,ND,MN)/60.
                 GOTO 942
  235        CONTINUE
                 TMCYCL(LK,ND)=0.00000001
                 WTQM(LK,ND,MN)=0.
                 QUE(LK,ND,MN)=0.
                 RHO(LK,ND)=0.
                 CUTF(LK,ND)=0.
                 CAPCTY(LK,ND)=0.
                 VARTM(LK,ND)=0.
                 SDEV(LK,ND)=0.
  942        CONTINUE
C
C  MULTIPLY THE WAITING TIME BY THE NUMBER OF NON-CONSTRAINING LOCKS
             IF(IS.NE.1.AND.LK.EQ.2)WTQM(LK,ND,MN)=WTQM(LK,ND,MN)
     +        *CALFAC
             IF(IS.NE.1.AND.LK.EQ.2)QUE(LK,ND,MN)=QUE(LK,ND,MN)*
     +         CALFAC
             ITMCYC(LK,ND,MN)=TMCYCL(LK,ND)+0.5
             ISDEV(LK,ND,MN)=SDEV(LK,ND)+0.5
             IF(IS.NE.1.AND.LK.EQ.2)GO TO 243
C
C  IF MAXIMUM LOCK UTILIZATION IS REACHED, CUT OFF THE TRANSITS
                DO 250 LC=3,LU
                   SOOAR(LK,LC,ND)=SOOAR(LK,LC,ND)*CUTF(LK,ND)
  250           CONTINUE
  243        CONTINUE
```

```
  242 CONTINUE
C
      RETURN
      END
C
C ****************************************************************
C
      SUBROUTINE CARTON(LU,LK,MN,IS,SYSFAC,SYSADD,SYSTIM,IROSUM)
C
      IMPLICIT INTEGER (I)
C
C
C  THE CARGO TONNAGE MODULE CALCULATES THE PROJECTED
C  AND THE ACTUAL CARGO TONNAGES PROCESSED BY THE LOCKS
C
      COMMON /PRJCOM/ IPCARG(3,15,15),PCARG(3,15,6)
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /QUECOM/ CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
      COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CUTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRAY(14),POEAR(12,2),POECL(2),RAMDA(4,2),RHO(4,2),RPMCL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDFCX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
C
      DIMENSION IROSUM(4)
C
      TCAGO=0.
      DO 450 MC=1,6
         CAGOCM(MC,MN)=0
         DO 2349 ND=1,2
            PCARG(ND,MN,MC)=0
 2349    CONTINUE
         DO 2312 LC=4,LU
            CAGOCL(MC,LC)=0
            DO 2313 ND=1,2
      LK=1
      IF(IS.NE.1) GO TO 2964
      IF(LU.LE.10.AND.LC.GE.8) LK=2
      IF(LU.GE.11.AND.LC.LE.7) LK=2
      IF(LU.GE.11.AND.LC.GE.8) LK=3
      IF(LU.GE.11.AND.LC.GE.11) LK=4
 2964          ACARGO=CTRNPM(MC,LC,ND)*CC(MC,LC)*CUTF(LK,ND)
               CAGOCL(MC,LC)=CAGOCL(MC,LC)+ACARGO*FLOAD(MC)
 2313       CONTINUE
            CAGOCL(MC,LC)=CAGOCL(MC,LC)/1000.
            CAGOCM(MC,MN)=CAGOCM(MC,MN)+CAGOCL(MC,LC)
            PCARG(1,MN,MC)=PCARG(1,MN,MC)+CTRNPM(MC,LC,2)
     +       *CC(MC,LC)*FLOAD(MC)/1000.0
            PCARG(2,MN,MC)=PCARG(2,MN,MC)+CTRNPM(MC,LC,1)
     +       *CC(MC,LC)*FLOAD(MC)/1000.0
 2312    CONTINUE
         PCARG(3,MN,MC)=PCARG(1,MN,MC)+PCARG(2,MN,MC)
  450 CONTINUE
      DO 2314 LC=4,LU
         SOR(1,LC,MN)=SOOAR(1,LC,2)
         SOR(2,LC,MN)=SOOAR(1,LC,1)
         SOR(4,LC,MN)=SOOAR(2,LC,2)
         SOR(5,LC,MN)=SOOAR(2,LC,1)
         SOR(7,LC,MN)=SOOAR(3,LC,2)
         SOR(8,LC,MN)=SOOAR(3,LC,1)
         SOR(10,LC,MN)= SOOAR(4,LC,2)
         SOR(11,LC,MN)= SOOAR(4,LC,1)
         DO 2237 MC=1,6
            ICTRNP(MC,LC,1)=ICTRNP(MC,LC,1)+IFIX(CTRNPM(
     +       MC,LC,2)+0.5)
            ICTRNP(MC,LC,2)=ICTRNP(MC,LC,2)+IFIX(CTRNPM(
     +       MC,LC,1)+0.5)
 2237    CONTINUE
 2314 CONTINUE
      IF (IS .EQ. 1 .AND. LU .GE. 12) GO TO 2241
```

```
      IRHO(1,MN) = RHO(1,1)*100+0.5
      IF( RHO(1,2).GE.RHO(1,1) ) IRHO(1,MN)=RHO(1,2)*100+0.5
 2241 IRHO(2,MN)=RHO(2,1)*100+0.5
      IF( RHO(2,2).GE.RHO(2,1) ) IRHO(2,MN)=RHO(2,2)*100+0.5
      IF(IS.NE.1)GO TO 964
         IRHO(3,MN)=RHO(3,1)*100+0.5
         IF( RHO(3,2).GE.RHO(3,1) ) IRHO(3,MN)=RHO(3,2)*100+0.5
         IF (LU .LE. 10) GO TO 991
         IRHO(4,MN)= RHO(4,1)*100+0.5
         IF (IRHO(4,2) .GT. IRHO(4,1)) IRHO(4,MN)= RHO(4,2)*100+0.5
         GO TO 991
  964 CONTINUE
         SYSTUP=TMCYCL(1,2)/120.+SYSFAC*TMCYCL(2,2)/120.+SYSADD
     +    +WTQM(1,2,MN)+WTQM(2,2,MN)
         SYSTDN=TMCYCL(1,1)/120.+SYSFAC*TMCYCL(2,1)/120.+SYSADD
     +    +WTQM(1,1,MN)+WTQM(2,1,MN)
         ISYSTM(MN)=(SYSTUP+SYSTDN+SYSTIM*TTI(MN))+0.5
         SYSQUE=(QUE(1,1,MN)+QUE(1,2,MN)+QUE(2,1,MN)+QUE(2,2,
     +     MN))/2.0
  991 CONTINUE
      IF (IS .NE. 1) GO TO 2242
      DO 2243 LK1= 1,4
         IF (LU .GE. 12 .AND. LK1 .EQ. 1) GO TO 2243
         IF (LU .LE. 10 .AND. LK1 .EQ. 4) GO TO 2243
      IF (MN .GE. 6 .AND. MN .LE. 12) IROSUM(LK1)= IROSUM(LK1)+
     +   IRHO(LK1,MN)
 2243 CONTINUE
      GO TO 2244
 2242 IF (MN .GE. 6 .AND. MN .LE. 12) IROSUM(1)= IROSUM(1)+IRHO(1,MN)
 2244 CONTINUE
C
      RETURN
      END
C
C ***************************************************
C
      SUBROUTINE QUEUE(IKNT1,LU)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM QUEUE PRINTS THE CORRECT HEADINGS
C  FOR THE QUEUEING TABLES
C
    1 FORMAT (/,43X,24H**** MACARTHUR LOCK ****)
    2 FORMAT (/,48X,18H**** POE LOCK ****)
    3 FORMAT (/,40X,31H**** SABIN AND DAVIS LOCKS ****)
C
      IF (LU .GE. 11) GO TO 101
      IF( IKNT1.NE.1 ) GOTO 100
         WRITE(8,1)
         GO TO 300
  100 CONTINUE
      IF( IKNT1.NE.2 ) GO TO 200
         WRITE(8,2)
         GO TO 300
  200 CONTINUE
         WRITE(8,3)
      GO TO 300
  101 IF (IKNT1 .NE. 1) GO TO 103
         WRITE (8,204)
      GO TO 300
  103 IF (IKNT1 .NE. 2) GO TO 104
         WRITE (8,1)
      GO TO 300
  104 IF (IKNT1 .NE. 3) GO TO 105
         WRITE (8,2)
      GO TO 300
  105 IF (IKNT1 .NE. 4) GO TO 300
         WRITE (8,106)
  204 FORMAT (/,45X,20H**** SABIN LOCK ****)
  106 FORMAT (/,43X,24H**** NEW DAVIS LOCK ****)
  300 CONTINUE
C
      RETURN
      END
C
C ***************************************************************
C
      SUBROUTINE SESONS(ISN,FACTOR,CAREX,EXTP,TDIN,DIN)
C
      IMPLICIT INTEGER (I)
C
```

```
C  SUBPROGRAM SESONS ASSIGNS THE CORRECT CARGO TONNAGE POTENTIAL
C  TO THE CARGO TONNAGE WORKING VARIABLE DEPENDING ON THE SEASON
C  EXTENSION
C
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /PRELIM/ IIT(3),ISES(4),ILTM(3)
C
      DIMENSION CAREX(6,2,80),EXTP(6,2,80),DIN(14,4)
C
          DO 1 IRINC=8,80,2
             IF(IRINC.EQ.16) IR=15
              IF(IRINC.EQ.16) GO TO 9820
 9821            IR=IRINC
 9820        DO 2 ND= 1,2
               DO 3 MC= 1,6
                  CARGOP(MC,ND,IR)= CAREX(MC,ND,IR)
C  INCREASE THE CARGO TONNAGE PROJECTIONS BY THE CARGO TONNAGE MULTIPLIER
                  CARGOP(MC,ND,IR)= CARGOP(MC,ND,IR)* FACTOR
    3          CONTINUE
    2       CONTINUE
            IF(IR.EQ.15) GO TO 9821
    1  CONTINUE
C
C   GET THE DESIRED CARGO POTENTIAL ASSIGNED TO THE WORKING VARIABLE
C   FOR THE CARGO POTENTIAL
C
      TDIN=0
      DO 997 MN=1,14
         TDIN=TDIN+DIN(MN,ISN)
  997 CONTINUE
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE TLOCMT(TLTML,LU,IS)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM TLOCMT ASSIGNS THE CORRECT LOCKING TIME RANGE TO
C  THE LOCKING TIME WORKING VARIABLE
C
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
C
      DIMENSION TLTML(12,2,2)
C
      DO 1 LC=4,LU
         DO 2 ND=1,2
            IF (IS .EQ. 1) TMLOCK(LC,ND,3)= TLTML(LC,ND,3)
            IF (IS .NE. 1) TMLOCK(LC,ND,1)= TLTML(LC,ND,1)
            IF( IS.NE.3 )TMLOCK(LC,ND,2)=TLTML(LC,ND,2)
    2    CONTINUE
    1 CONTINUE
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE READIN (ISYST,IS,LU,KU,FACTOR,CALFAC,SYSFAC,
     + SYSADD,SYSTIM,BTF4,BTF5,BTF13,BTF14,IDFCX,IDEBUG,CARF)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM READIN READS THE APPROPRIATE DATA FILE
C
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /BINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /PRELIM/ IIT(3),ISES(4),ILTM(3)
      COMMON /DAT1/ BTF(14,4),CAREX1(6,2,80),CAREX2(6,2,80),
     + DATM(14),DIN(14,4),DIST(6),
     + EXTP1(6,2,80),EXTP2(6,2,80),
     + IZBH(12),LYEAR(80),ODAYS(12),PCRF(14,2),SCOST(12),STDEV(12,2,4),
     + TLTML2(12,2,4),TLTML3(12,2,4),TURNBK(4),UNLOAD(12),XCAP(12),
     + XSHIP(12),ZB(12),GBAL(12),GLOAD(12)
```

```
      COMMON /COMMOD/ WHEAT(80,3),SOY(80,3),BLYRYE(80,3),CORN(80,3),
     +  OILSD(80,3),ALMSTN(80,3),AIRORE(80,3),RAWMAT(80,3),
     +  COAL(80,3),PETROL(80,3),DRYBLK(80,3),GENCAR(80,3),
     +  STLPRD(80,3),GRAIN(80,3),STONE(80,3),ORE(80,3),BULK(80,3),
     +  GNCAR(80,3),CEMENT(80,3),AMIN(80,3)
C
      DIMENSION TDFCX(5,4)
      DIMENSION CARF(3,15,80)
C
      LOGICAL IDEBUG
C
    5 FORMAT (1X)
  603 FORMAT(/)
C
C **** MAXIMUM VESSEL CLASS IN ****
      READ(ISYST,506) LU
  506 FORMAT (I2)
      IF ( IDEBUG ) WRITE (9,506) LU
C **** SEASON EXTENSION IN ****
      READ(ISYST,507) (ISES(I),I=1,4)
      IF( IDEBUG )WRITE(9,507) (ISES(I),I=1,4)
  507 FORMAT (I1,3(1X,I1))
C **** LOCKING TIMES IN ****
      READ(ISYST,996) (ILTM(I),I=1,3)
      IF( IDEBUG )WRITE(9,996) (ILTM(I),I=1,3)
  996 FORMAT (I1,2(1X,I1))
C ***** ZBHF, FACTORS IN *****
      READ(ISYST,14) (ZBHF(LC),LC=4,LU)
      IF( IDEBUG )WRITE(9,14) (ZBHF(LC),LC=4,LU)
      READ(ISYST,1517) FACTOR,CALFAC,SYSFAC,SYSADD,SYSTIM
      IF( IDEBUG )WRITE(9,1517) FACTOR,CALFAC,SYSFAC,SYSADD,SYSTIM
   14 FORMAT (8(F4.2,1X))
 1517 FORMAT(2(F4.2,1X),3(F5.2,1X))
      IF( IDEBUG )WRITE(9,603)
C **** READ IN THE FLEET MIX FACTORS
C     SHIP BUILDING FACTORS
      READ (ISYST,603)
      READ(ISYST,7700) ((ADDPCT(MC,LC),MC=1,6),LC=4,LU)
      IF( IDEBUG )WRITE(9,7700)((ADDPCT(MC,LC),MC=1,6),LC=4,LU)
 7700 FORMAT (6F6.2)
C **** CC IN
      READ (ISYST,603)
      IF(IS.NE.1)READ(ISYST,602)((CC(MC,LC),LC=4,LU),MC=1,3)
      IF(IS.NE.1.AND.IDEBUG )WRITE(9,602)((CC(MC,LC),LC=4,LU),
     + MC=1,3)
  602 FORMAT(4(F6.0,1X))
      IF(IS.EQ.1)READ(ISYST,/)((CC(MC,LC),LC=4,LU),MC=1,3)
      IF(IS.EQ.1 .AND. IDEBUG )WRITE(9,7)((CC(MC,LC),LC=4,LU),MC=1,3)
    7 FORMAT(7F7.0)
C ***** TDF IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,8)((TDF(LC,MN),MN=1,14),LC=1,3)
      IF( IDEBUG )WRITE(9,8)((TDF(LC,MN),MN=1,14),LC=1,3)
    8 FORMAT(14F5.3)
C  ***** READ IN THE PROJECTED COMMODITY TONNAGES *****
           DO 8000 J=1,9
                J1=J-1
                 IF(J1.EQ.0) IR=8
                IF(J1.EQ.1) IR=15
                IF(J1.GE.2) IR=J1*10
           DO 8030 ND= 1,2
        READ (ISYST,603)
          READ(ISYST,8040) WHEAT(IR,ND),SOY(IR,ND),
     +       BLYRYE(IR,ND),CORN(IR,ND),OILSD(IR,ND),
     +       ALMSTN(IR,ND),AIRORE(IR,ND),
     +       RAWMAT(IR,ND),COAL(IR,ND),PETROL(IR,ND)
     +       ,CEMENT(IR,ND),AMIN(IR,ND),
     +       DRYBLK(IR,ND),GENCAR(IR,ND),
     +       STLPRD(IR,ND)
 8040       FORMAT (10F8.0,/,5F8.0)
      IF ( IDEBUG ) WRITE (9,8040) WHEAT(IR,ND),
     +  SOY(IR,ND),BLYRYE(IR,ND),CORN(IR,ND),
     +  OILSD(IR,ND),ALMSTN(IR,ND),AIRORE(IR,ND),
     +  RAWMAT(IR,ND),COAL(IR,ND),PETROL(IR,ND),
     +  CEMENT(IR,ND),AMIN(IR,ND),DRYBLK(IR,ND),
     +  GENCAR(IR,ND),STLPRD(IR,ND)
 8030       CONTINUE
C  CALCULATE THE TOTAL DEMAND FOR EACH COMMODITY
         WHEAT(IR,3)= WHEAT(IR,1)+ WHEAT(IR,2)
         SOY(IR,3)= SOY(IR,1)+ SOY(IR,2)
         BLYRYE(IR,3)= BLYRYE(IR,1)+ BLYRYE(IR,2)
         CORN(IR,3)= CORN(IR,1)+ CORN(IR,2)
         OILSD(IR,3)= OILSD(IR,1)+ OILSD(IR,2)
```

```
      ALMSTN(IR,3)= ALMSTN(IR,1)+ ALMSTN(IR,2)
      AIRORE(IR,3)= AIRORE(IR,1)+ AIRORE(IR,2)
      RAWMAT(IR,3)= RAWMAT(IR,1)+ RAWMAT(IR,2)
      PETROL(IR,3)= PETROL(IR,1)+ PETROL(IR,2)
      CEMENT(IR,3)= CEMENT(IR,1)+ CEMENT(IR,2)
      AMIN(IR,3)= AMIN(IR,1)+ AMIN(IR,2)
      DRYBLK(IR,3)= DRYBLK(IR,1)+ DRYBLK(IR,2)
      GENCAR(IR,3)= GENCAR(IR,1)+ GENCAR(IR,2)
      STLPRD(IR,3)= STLPRD(IR,1)+ STLPRD(IR,2)
C  CONVERT TO THE SIX MAJOR COMMODITY GROUPS
      DO 8031 ND= 1,3
         GRAIN(IR,ND)= WHEAT(IR,ND)+ SOY(IR,ND)+
     +        BLYRYE(IR,ND)+ CORN(IR,ND)+ OILSD(IR,ND)
         STONE(IR,ND)= ALMSTN(IR,ND)
         ORE(IR,ND)= AIRORE(IR,ND)
         BULK(IR,ND)= RAWMAT(IR,ND)+
     +        PETROL(IR,ND)+ CEMENT(IR,ND)+
     +        AMIN(IR,ND)+ DRYBLK(IR,ND)
         GNCAR(IR,ND)= GENCAR(IR,ND)+STLPRD(IR,ND)
 8031    CONTINUE
C  ASSIGN THE CARGO PROJECTIONS TO THE CORRECT WORKING VARIABLE
      IF (ISES(1) .EQ. 1) GO TO 8888
         DO 8050 ND= 1,2
         CAREX2(1,ND,IR)= ORE(IR,ND)
         CAREX2(2,ND,IR)= COAL(IR,ND)
         CAREX2(3,ND,IR)= STONE(IR,ND)
         CAREX2(4,ND,IR)= GRAIN(IR,ND)
         CAREX2(5,ND,IR)= BULK(IR,ND)
         CAREX2(6,ND,IR)= GNCAR(IR,ND)
         EXTP2(4,ND,IR)= 0.0
         EXTP2(6,ND,IR)= 0.0
 8050    CONTINUE
         GO TO 8889
 8888    DO 8887 ND= 1,2
            CAREX1(1,ND,IR)= ORE(IR,ND)
            CAREX1(2,ND,IR)= COAL(IR,ND)
            CAREX1(3,ND,IR)= STONE(IR,ND)
            CAREX1(4,ND,IR)= GRAIN(IR,ND)
            CAREX1(5,ND,IR)= BULK(IR,ND)
            CAREX1(6,ND,IR)= GNCAR(IR,ND)
            EXTP1(4,ND,IR)= 0.0
            EXTP1(6,ND,IR)= 0.0
 8887    CONTINUE
C CALCULATE FRACTIONS OF THE MAJOR COMMODITY GROUPS FOR EACH
C INDIVIDUAL COMMODITY
 8889    DO 8800 N=1,3
            IF (N .EQ. 1) ND1= 2
            IF (N .EQ. 2) ND1= 1
            IF (N .EQ. 3) ND1= 3
            IF (GRAIN(IR,ND1) .LT. 0.5) GO TO 8801
            CARF(N,1,IR)= WHEAT(IR,ND1)/GRAIN(IR,
     +           ND1)
            CARF(N,2,IR)= SOY(IR,ND1)/GRAIN(IR,
     +           ND1)
            CARF(N,3,IR)= BLYRYE(IR,ND1)/GRAIN(IR
     +           ,ND1)
            CARF(N,4,IR)= CORN(IR,ND1)/GRAIN(IR,
     +           ND1)
            CARF(N,5,IR)= OILSD(IR,ND1)/GRAIN(IR,
     +           ND1)
            GO TO 8802
 8801       DO 8803 K= 1,5
               CARF(N,K,IR)= 0.0
 8803       CONTINUE
 8802       CARF(N,6,IR)= 1.0
            CARF(N,7,IR)= 1.0
            CARF(N,8,IR)= 1.0
            IF (BULK(IR,ND1) .LT. 0.5) GO TO 8804
            CARF(N,9,IR)= RAWMAT(IR,ND1)/BULK(IR,
     +           ND1)
            CARF(N,10,IR)= PETROL(IR,ND1)/BULK(IR,
     +           ND1)
            CARF(N,11,IR)= CEMENT(IR,ND1)/BULK(IR,
     +           ND1)
            CARF(N,12,IR)= AMIN(IR,ND1)/BULK(IR,
     +           ND1)
            CARF(N,13,IR)= DRYBLK(IR,ND1)/BULK(IR,
     +           ND1)
            GO TO 8805
 8804       DO 8806 K= 9,13
               CARF(N,K,IR)= 0.0
 8806       CONTINUE
 8805       IF (GNCAR(IR,ND1) .LT. 0.5) GO TO 8807
            CARF(N,14,IR)= GENCAR(IR,ND1)/GNCAR(IR,
     +           ND1)
```

```
                CARF(N,15,IR)= STLPRD(IR,ND1)/GNCAR(IR,
     +            ND1)
                GO TO 8800
 8807           DO 8808 K= 14,15
                  CARF(N,K,IR)= 0.0
 8808           CONTINUE
 8800         CONTINUE
 8000 CONTINUE
C  ***** HOURS IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,21)(DATM(MN),MN=1,14)
      IF( IDEBUG )WRITE(9,21)(DATM(MN),MN=1,14)
   21 FORMAT (14(F4.1,1X))
C  ***** TMLOCK IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF(IS.EQ.1)READ(ISYST,22)(((TMLOCK(LC,ND,J),LC=4,LU),ND=1,
     + 2),J=1,2)
      IF(IS.EQ.1 .AND. IDEBUG )WRITE(9,22)(((TMLOCK(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
      IF(IS.NE.1)READ(ISYST,753)(((TMLOCK(LC,ND,J),LC=4,LU),ND=1,
     + 2),J=1,2)
      IF(IS.NE.1 .AND. IDEBUG )WRITE(9,753)(((TMLOCK(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
  753 FORMAT(4(F5.0,1X))
   22 FORMAT(7F6.1)
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF( IS.EQ.1 ) READ(ISYST,22)((TLTML2(LC,ND,1),LC=4,LU),ND=1,2)
      IF( IS.EQ.1 .AND. IDEBUG )WRITE(9,22)((TLTML2(LC,ND,1),LC=4,LU),
     + ND=1,2)
      IF( IS.NE.1 ) READ(ISYST,753)(((TLTML2(LC,ND,J),LC=4,LU),
     +   ND=1,2),J=1,2)
      IF( IS.NE.1 .AND. IDEBUG )WRITE(9,753)(((TLTML2(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF(IS.EQ.1) READ(ISYST,22)((TLTML3(LC,ND,1),LC=4,LU),ND=1,2)
      IF(IS.EQ.1 .AND. IDEBUG )WRITE(9,22)((TLTML3(LC,ND,1),LC=4,LU),
     + ND=1,2)
      IF(IS.NE.1) READ(ISYST,753)(((TLTML3(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
      IF(IS.NE.1 .AND. IDEBUG )WRITE(9,753)(((TLTML3(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
C  ***** ST. DEV IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF(IS.EQ.1)READ(ISYST,22)(((STDEV(LC,ND,J),LC=4,LU),ND=1,
     + 2),J=1,2)
      IF(IS.EQ.1 .AND. IDEBUG )WRITE(9,22)(((STDEV(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
      IF(IS.NE.1)READ(ISYST,754)(((STDEV(LC,ND,J),LC=4,LU),ND=1,
     + 2),J=1,2)
      IF(IS.NE.1 .AND. IDEBUG )WRITE(9,754)(((STDEV(LC,ND,J),LC=4,LU),
     + ND=1,2),J=1,2)
  754 FORMAT(4(F5.1,1X))
      IF(IS.NE.1) GO TO 1001
      DO 1002 LC=4,LU
        DO 1003 ND=1,2
        TMLOCK(LC,ND,3)=TMLOCK(LC,ND,2)
        TLTML2(LC,ND,3)=TLTML2(LC,ND,2)
        TLTML3(LC,ND,3)=TLTML3(LC,ND,2)
        STDEV(LC,ND,3)=STDEV(LC,ND,2)
 1003   CONTINUE
 1002 CONTINUE
 1001 CONTINUE
C ***** VALIDATION BTF IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,700)BTF4,BTF5,BTF13,BTF14
      IF( IDEBUG )WRITE(9,700)BTF4,BTF5,BTF13,BTF14
  700 FORMAT(4(F5.2,1X))
C  ***** TURNBK IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,23)(TURNBK(LK),LK=1,KU)
      IF( IDEBUG )WRITE(9,23)(TURNBK(LK),LK=1,KU)
   23 FORMAT(3(F5.0,1X))
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
C ***** XSHIP IN *****
      READ(ISYST,25)(XSHIP(LC),LC=4,LU)
      IF( IDEBUG )WRITE(9,25)(XSHIP(LC),LC=4,LU)
```

```
   25 FORMAT(8F8.0)
C ***** XCAP IN *****
      READ(ISYST,25)(XCAP(LC),LC=4,LU)
      IF( IDEBUG )WRITE(9,25)(XCAP(LC),LC=4,LU)
C  ***** NON-C IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,617) ((PCRF(MN,ND),MN=1,14),ND=1,2)
      IF( IDEBUG )WRITE(9,617) ((PCRF(MN,ND),MN=1,14),ND=1,2)
  617 FORMAT(14(F4.1,1X))
C  ***** FLOAD IN
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,618) (FLOAD(MC),MC=1,6)
      IF( IDEBUG )WRITE(9,618) (FLOAD(MC),MC=1,6)
  618 FORMAT (6F4.2)
C ***** DISTN IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,629)((DISTN(ND,MC),MC=1,6),ND=1,2)
      IF( IDEBUG )WRITE(9,629)((DISTN(ND,MC),MC=1,6),ND=1,2)
  629 FORMAT(6F7.1)
C ***** FILL IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,629)((FILL(MC,LC),MC=1,6),LC=4,LU)
      IF( IDEBUG )WRITE(9,629)((FILL(MC,LC),MC=1,6),LC=4,LU)
C ***** EMPTY IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,629)((EMPTY(MC,LC),MC=1,6),LC=4,LU)
      IF( IDEBUG )WRITE(9,629)((EMPTY(MC,LC),MC=1,6),LC=4,LU)
C ***** HRS IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,621)(((HRS(MN,ISA,MC),MN=1,14),MC=1,6),ISA=1,4)
      IF( IDEBUG )WRITE(9,621)(((HRS(MN,ISA,MC),MN=1,14),MC=1,6),
     + ISA=1,4)
  621 FORMAT(14F5.1)
C ***** VSA IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,313)(((VSA(MN,LC,ISA),MN=1,14),LC=4,LU),ISA=1,4)
      IF( IDEBUG )WRITE(9,313)(((VSA(MN,LC,ISA),MN=1,14),LC=4,LU),
     + ISA=1,4)
C ***** DIN IN ****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,313)((DIN(MN,ISA),MN=1,14),ISA=1,4)
      IF( IDEBUG )WRITE(9,313)((DIN(MN,ISA),MN=1,14),ISA=1,4)
  313 FORMAT(14F5.2)
C  ***** READ IN RETIREMENT PERCENTAGES  *****
      READ (ISYST,603)
      DO 7710 J=1,9
      J1=J-1
      IF(J1.EQ.0) IR=8
      IF(J1.EQ.1) IR=15
      IF(J1.GE.2) IR=J1*10
 7730    IF (IS .EQ. 1) READ(ISYST,624) (PO(IR,LC),LC=4,LU)
         IF (IS .EQ. 1 .AND. IDEBUG ) WRITE(9,624) (PO(IR,LC)
     +     ,LC=4,LU)
         IF (IS .NE. 1) READ(ISYST,787) (PO(IR,LC),LC=4,LU)
         IF (IS .NE. 1 .AND. IDEBUG ) WRITE(9,787) (PO(IR,
     +     LC),LC=4,LU)
 7710 CONTINUE
  787 FORMAT(4F5.2)
  624 FORMAT(8F5.2)
C ***** BASEFT IN *****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF(IS.EQ.1)READ(ISYST,633)((BASEFT(MC,LC),LC=4,LU),MC=1,6)
      IF(IS.EQ.1 .AND.IDEBUG )WRITE(9,633)((BASEFT(MC,LC),LC=4,LU),
     + MC=1,6)
      IF(IS.NE.1)READ(ISYST,634)((BASEFT(MC,LC),LC=4,LU),MC=1,6)
      IF(IS.NE.1 .AND. IDEBUG )WRITE(9,634)((BASEFT(MC,LC),LC=4,LU),
     + MC=1,6)
  633 FORMAT(7F6.2)
  634 FORMAT(4(F5.2,1X))
C ***** BTF IN ****
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      READ(ISYST,313)((BTF(MN,ISA),MN=1,14),ISA=1,4)
      IF( IDEBUG )WRITE(9,313)((BTF(MN,ISA),MN=1,14),ISA=1,4)
C ***** TUFCX IN *****
```

```
      READ(ISYST,603)
      IF( IDEBUG )WRITE(9,603)
      IF( IS.EU.1 )READ(ISYST,407)((TDFCX(M,I),M=1,3),I=2,4)
      IF( IS.EQ.1 .AND. IDEBUG )WRITE(9,407)((TDFCX(M,I),M=1,3),I=2,4)
      IF( IS.NE.1 )READ(ISYST,406)((TDFCX(M,I),M=1,5),I=2,4)
      IF( IS.NE.1 .AND. IDEBUG )WRITE(9,406)((TDFCX(M,I),M=1,5),I=2,4)
  407 FORMAT (3(F6.4,1X))
  406 FORMAT (5(F6.4,1X))
C ***** READ INCREASES IN CAPACITY WITH DEPTH *****
      READ (ISYST,603)
      IF ( IDEBUG ) WRITE (9,603)
      READ (ISYST,9900) (CAPINC(LC),LC= 4,LU)
      IF ( IDEBUG ) WRITE (9,9900) (CAPINC(LC),LC=4,LU)
 9900 FORMAT (11F7.2)
      DO 1518 LC=4,LU
         SCOST(LC)=XSHIP(LC)+XCAP(LC)
         CC(4,LC)=CC(2,LC)
         CC(5,LC)=CC(3,LC)
         CC(6,LC)=CC(3,LC)
         CC(3,LC)=CC(1,LC)
         GLOAD(LC)=0
         GBAL(LC)=0
         ZB(LC)=ZBHF(LC)
         IZBH(LC)=100*ZB(LC)+0.5
 1518 CONTINUE
      DO 15 MN=1,14
         IF(IS.NE.1)GO TO 18
            TDF(4,MN)=TDF(1,MN)
            TDF(5,MN)=TDF(1,MN)
            TDF(6,MN)=TDF(2,MN)
            TDF(7,MN)=TDF(2,MN)
            TDF(8,MN)=TDF(2,MN)
            TDF(9,MN)=TDF(2,MN)
            TDF(10,MN)=TDF(3,MN)
            TDF(11,MN)=TDF(3,MN)
            GOTO 15
   18    CONTINUE
            TDF(4,MN)=TDF(1,MN)
            TDF(6,MN)=TDF(1,MN)
            TDF(5,MN)=TDF(2,MN)
            TDF(7,MN)=TDF(2,MN)
   15 CONTINUE
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE HEADER (IS,INUMB,IR,ISN,ILTML)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM HEADER PRINTS THE PAGE HEADING,
C  PAGE NUMBERS AND INCLUDES CARRIAGE CONTROLS
C
      COMMON /MEDCOM/ IMO(14),IYR(80)
      INTEGER ILT(3)
C
      DATA ILT / 4HNORM,4H LOW,4HHIGH /
C
    2 FORMAT (I1,2X)
  100 FORMAT(38X,36H**** GL/SLS LOCK CAPACITY MODEL ****,
     + 32X,5HPAGE ,I2,4H OF ,I2)
  110 FORMAT (44X,25H**** SOO LOCK SYSTEM ****,25X,8A2,2X,4A2)
  120 FORMAT (45X,23H**** WELLAND CANAL ****,26X,8A2,2X,4A2)
  130 FORMAT (41X,28H**** ST. LAWRENCE RIVER ****,25X,8A2,2X,4A2)
  140 FORMAT (49X,5H**** ,I4,5H ****,/
     + 32X22H**** SEASON EXTENSION ,I1,16H!  LOCKING TIME ,A4,
     + 5H ****)
  150 FORMAT(/)
C
      NEXPG=1
      INUMB = INUMB+1
      IPGS=9
      IF( IS.EQ.1 ) IPGS=11
      WRITE(8,2) NEXPG
      WRITE(8,100)INUMB,IPGS
      IF( IS.EU.1 )WRITE(8,110)
      IF( IS.EQ.2 )WRITE(8,120)
      IF( IS.EQ.3 )WRITE(8,130)
      WRITE(8,140) IYR(IR),ISN,ILT(ILTML)
      WRITE(8,150)
C
      RETURN
      END
```

```
      SUBROUTINE OUTMOD(LC,LU,IS,INUMB,IR,ISN,ILINL,NEXPG,
     +  ICAP,CARF)
C
      IMPLICIT INTEGER (I)
      DIMENSION SORTOL(12,14),SORTOT(3,14)
C
C
C THE OUTPUT MODULE CONTAINS 7 SUBPROGRAMS THAT PRINT 7 TABLES
C AND PRINTS 2 ADDITIONAL TABLES WITHIN THE MODULE BODY
C
      COMMON /MEDCOM/  IBMO(14),IYR(80)
      COMMON /QUECOM/ CAGOCL(6,12),IDBTRN(12,3,14),IDLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRMO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),ITOT(3,3),
     + ITOTC(2,6),ITTCST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
      COMMON/Q/ARTAR(12,2),ARTCL(2),ARTPOE(2),AVGVAR(4,2),
     + CAPCTY(4,2),CYTF(4,2),DTLOCK(4,2),LMAX(12),LMIN(12),
     + MONRA:(14),POEAR(12,2),POECL(2),KAMDA(4,2),RHO(4,2),RPMCL(2),
     + SABAR(12,2),SDEV(4,2),SHIP(12,6),SOOAR(4,12,2),TBAL(14,12),
     + TBALT(12),TDCST(4,12),TDPCX(5,4),TIMES(14),TLOAD(14,12),
     + TLOADT(12),TMCYCL(4,2),TMEAN(4,2),TTI(14),
     + VARTM(4,2),TLOCKM(4,2),DAVAR(12,2)
      COMMON /COMMOD/ WHEAT(80,3),SOY(80,3),BLYRYE(80,3),CORN(80,3),
     +  OILSD(80,3),ALMSTN(80,3),AIRORE(80,3),KAWMAT(80,3),
     +  COAL(80,3),PETROL(80,3),DRYBLK(80,3),GENCAR(80,3),
     +  STLPRD(80,3),GRAIN(80,3),STONE(80,3),ORE(80,3),BULK(80,3),
     +  GNCAR(80,3),CEMENT(80,3),AMIN(80,3)
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     +  EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     +  PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     +  WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
C
      DIMENSION CARF(3,15,80)
C
    9 FORMAT(I1)
  795 FORMAT (2X,I2,1X,6(1X,I6,2X,I6,4X))
  797 FORMAT (5X,6(2X,5(1H-),3X,5(1H-),4X),/,
     +  1X,5HTOTAL,I6,2X,I6,4X,5(1X,I6,2X,I6,4X))
 2259 FORMAT (///,16X,15HLOADED TRANSITS,23X,9HBALLASTED,
     + 9H TRANSITS,26X,5HTOTAL,//,
     + 20X,5HTOTAL,33X,5HTOTAL,34X,3HALL,/,
     + 1X,5HCLASS,2(10X,2HUP,10X,2HDN,7X,5HTOTAL,2X),10X,2HUP,
     + 10X,2HDN,7X,5HTOTAL)
 2260 FORMAT (2X,I2,2X,3(3X,2(I9,3X),I9,2X))
 2263 FORMAT(4X,3(8X,2(6H------,6X),6H------))
 2262 FORMAT(1X,5HTOTAL,3(3X,2(I9,3X),I9,2X))
  110 FORMAT (11(/))
  125 FORMAT (7(/))
  113 FORMAT (33X,39H##### DAILY TRANSIT DEMAND BY MONTH AND ,
     + 10HCLASS ####,)
  121 FORMAT(/,28X,A8,45X,A8)
  122 FORMAT(2X,2(12X,2HUP,16X,2HDN,13X,9HTOTAL     ),/,
     + 1X,5HCLASS,6(10H LOAD BLST TOTAL  ))
  224 FORMAT(2X,I2,6(2X,2(1X,F4.1),1X,F5.1))
  225 FORMAT(4X,6(2X,2(1X,4H----),1X,5H-----),/,
     + 1X,5HTOTAL,6(2(1X,F4.1),1X,F5.1,2X))
  118 FORMAT (50X,9HCONTINUED)
  128 FORMAT (9(/))
  123 FORMAT (7(/))
  126 FORMAT (12(/))
 2100 FORMAT (31X,25H##### YEARLY TRANSITS BY ,
     + 25HCOMMODITY AND CLASS #####,///,
     + 47X,15HLOADED TRANSITS,//,
     +  13X,3HORE,15X,4HCOAL,15X,5HSTONE,14X,5HGRAIN,12X,
     +  10HOTHER BULK,9X,9HGEN CARGO,/,
     +  1X,5HCLASS,5(4X,2HUP,6X,2HDN,5X),4X,2HUP,6X,2HDN)
C
      INUMB= 0
      WRITE(8,9) NEXPG
      IF(IS.NE.1) GO TO 7791
      DO 986 LC=3,LU
         DO 985 MN=1,14
            DO 987 K=3,12,3
               SOR(K,LC,MN)=0
  987       CONTINUE
            DO 975 K=1,12
               SOR(K,LC,MN)=IFIX(10.* SOR(K,LC,MN)+ 0.5)*0.1
  975       CONTINUE
  985    CONTINUE
```

```
 984 CONTINUE
     DO 984 MN=1,14
        DO 983 LC=3,LU
           DO 982 ND=1,2
              SOR(3,LC,MN)=SOR(3,LC,MN)+SOR(ND,LC,MN)
              SOR(6,LC,MN)=SOR(6,LC,MN)+SOR((ND+3),LC,MN)
              SOR(9,LC,MN)=SOR(9,LC,MN)+SOR((ND+6),LC,MN)
              SOR(12,LC,MN)= SOR(12,LC,MN)+SOR((ND+9),LC,MN)
 982       CONTINUE
 983    CONTINUE
 984 CONTINUE
     DO 7792 K=1,12
        DO 7793 J=1,14
         SORTOL(K,J)=0.0
7793 CONTINUE
7792 CONTINUE
     DO 7794 J=1,14
        DO 7795 K=1,12
         DO 7796 LC=3,LU
           SORTOL(K,J)=SORTOL(K,J)+SOR(K,LC,J)
7796 CONTINUE
7795 CONTINUE
7794 CONTINUE
     GO TO 7797
7791 CONTINUE
     DO 5 IA = 1,3
        DO 7 IB=1,14
           SORTOT(IA,IB)=0
   7    CONTINUE
   5 CONTINUE
     DO 8 MN=1,14
        DO 90 LC=3,LU
           DO 10 ND=1,2
              SOR(ND,LC,MN)=IFIX(10.* SOR(ND,LC,MN)+ 0.5)*0.1
  10       CONTINUE
           SOR(3,LC,MN)=SOR(1,LC,MN)+SOR(2,LC,MN)
           DO 11 ND=1,3
              SORTOT(ND,MN)=SORTOT(ND,MN)+SOR(ND,LC,MN)
  11       CONTINUE
  90     CONTINUE
   8 CONTINUE
7797 CONTINUE
     IPRINT=0
     IF(IR.EQ.8) GO TO 7557
     IF(IR.EQ.15) GO TO 7557
     DO 7549 J=20,80,10
     IF(IR.EQ.J) IPRINT=1
7549 CONTINUE
     IF(IPRINT.EQ.1) GO TO 7557
     IF(ICAP.GE.1) GO TO 7548
     CALL QUETAB(IS,INUMB,IR,ISN,ILTML,SORTOL,
    +  SORTOT,LU)
     GO TO 7552
7548 CONTINUE
     IF(IR.GT.20) GO TO 7553
     IF(IR.LT.15) GO TO 7554
     YEAR=IR*1.0-15.0
     DO 7555 N= 1,3
        DO 7556 M= 1,15
     CARF(N,M,IR)=CARF(N,M,15)+(YEAR/5.0)*(CARF(N,M,20)-CARF(N,M,15))
7556    CONTINUE
7555 CONTINUE
     GO TO 7557
7554 YEAR=IR*1.0-8.0
     DO 7558 N= 1,3
        DO 7559 M= 1,15
     CARF(N,M,IR)=CARF(N,M,8)+(YEAR/7.0)*(CARF(N,M,15)-CARF(N,M,8))
7559    CONTINUE
7558 CONTINUE
     GO TO 7557
7553 DO 33 I=2,7
     DO 32 J1=2,8,2
     IYEAR=I*10+J1
     IF(IR.EQ.IYEAR) IDEC=I*10
  32 CONTINUE
  33 CONTINUE
     IDEC1=IDEC+10
     YEAR=(IR-IDEC)*1.0
     DO 7561 N= 1,3
        DO 7562 M=1,15
    CARF(N,M,IR)=CARF(N,M,IDEC)+(YEAR/10.0)*(CARF(N,M,IDEC1)
   +-CARF(N,M,IDEC))
7562    CONTINUE
7561 CONTINUE
7557 CONTINUE
```

```
C *****  PROJECTED CARGO TABLE  *****
C *****  FLEET MIX TABLE  *****
C *****  VESSEL CHARACTERISTICS TABLE  *****
C
      CALL PROJCR (IS,INUMB,IR,ISN,ILTML,CARF)
      CALL MIX (LU,IS,INUMB,IR,ISN,ILTML,SHIP)
      CALL VESCHR (IS,LU,LMIN,LMAX)
C
C *****  YEARLY TRANSITS TABLE  *****
C
      DO 2361 IA=1,LU
         DO 2362 IB=1,2
            ILTR(IB,IA)=0
            ITLTR(IB,IA)=0
            IDBTRN(IA,IB)=0
            IDLTRN(IA,IB)=0
            XDBTRN(IA,IB)=0.
            XDLTRN(IA,IB)=0.
 2362    CONTINUE
         ILTR(3,IA)=0
         ITLTR(3,IA)=0
         IDBTRN(IA,3)=0
         IDLTRN(IA,3)=0
 2361 CONTINUE
      DO 2364 IA=1,3
         DO 2365 IB=1,3
            ITOT(IB,IA)=0
 2365    CONTINUE
 2364 CONTINUE
      DO 2366 IA=1,6
         DO 2367 IB=1,2
            ITOTC(IB,IA)=0
 2367    CONTINUE
 2366 CONTINUE
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
      WRITE(8,2100)
      DO 105 LC=4,LU
         DO 107 MN=1,14
            XDBTRN(LC,2)=XDBTRN(LC,2)+DBTRN(LC,1,MN)*DM(MN)
            XDBTRN(LC,1)=XDBTRN(LC,1)+DBTRN(LC,2,MN)*DM(MN)
            XDLTRN(LC,2)=XDLTRN(LC,2)+DLTRN(LC,1,MN)*DM(MN)
            XDLTRN(LC,1)=XDLTRN(LC,1)+DLTRN(LC,2,MN)*DM(MN)
  107    CONTINUE
         IDBTRN(LC,1)=XDBTRN(LC,1)+0.5
         IDBTRN(LC,2)=XDBTRN(LC,2)+0.5
         IDLTRN(LC,1)=XDLTRN(LC,1)+0.5
         IDLTRN(LC,2)=XDLTRN(LC,2)+0.5
         DO 109 MC=1,6
            DO 102 ND=1,2
               ITOTC(ND,MC)=ITOTC(ND,MC)+ICTRNP(MC,LC,ND)
               ILTR(ND,LC)=ILTR(ND,LC)+ICTRNP(MC,LC,ND)
  102       CONTINUE
  109    CONTINUE
         IDBTRN(LC,3)=IDBTRN(LC,1)+IDBTRN(LC,2)
         IDLTRN(LC,3)=IDLTRN(LC,1)+IDLTRN(LC,2)
         ILTR(3,LC)=ILTR(1,LC)+ILTR(2,LC)
         DO 104 ND=1,3
            ITLTR(ND,LC)=ILTR(ND,LC)+IDBTRN(LC,ND)
            ITOT(ND,1)=ITOT(ND,1)+ILTR(ND,LC)
            ITOT(ND,2)=ITOT(ND,2)+IDBTRN(LC,ND)
            ITOT(ND,3)=ITOT(ND,3)+ITLTR(ND,LC)
  104    CONTINUE
  105 CONTINUE
      DO 799 LC= 4,LU
         WRITE(8,795)LC,((ICTRNP(MC,LC,I),I=1,2),MC=1,6)
  799 CONTINUE
      WRITE(8,757)((ITOTC(ND,MC),ND=1,2),MC=1,6)
      WRITE(8,2259)
      DO 2261 LC=4,LU
         WRITE(8,2260)LC,(ILTR(I,LC),I=1,3),(IDBTRN(LC,I),
     +    I=1,3),(ITLTR(I,LC),I=1,3)
 2261 CONTINUE
      WRITE(8,2263)
      WRITE(8,2262)((ITOT(ND,NE),ND=1,3),NE=1,3)
      WRITE(8,110)
      IF( IS.NE.1 ) WRITE(8,125)
C
C *****  DAILY TRANSIT DEMAND TABLE  *****
C
      DO 2369 IA=1,14
         DO 2371 IB=1,3
            DO 2372 IC=1,LU
               DT(IC,IB,IA)=0
```

```
 2372        CONTINUE
             TOTDL(IB,IA)=0.
             TOTDB(IB,IA)=0.
             TOTDT(IB,IA)=0.
 2371     CONTINUE
 2369 CONTINUE
      DO 111 MN=1,14
         DO 112 LC=4,LU
            HOLD=DLTRN(LC,1,MN)
            DLTRN(LC,1,MN)=DLTRN(LC,2,MN)
            DLTRN(LC,2,MN)=HOLD
            HOLD=DBTRN(LC,1,MN)
            DBTRN(LC,1,MN)=DBTRN(LC,2,MN)
            DBTRN(LC,2,MN)=HOLD
  112    CONTINUE
  111 CONTINUE
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
      WRITE(8,113)
      DO 114 MN=1,14
         DO 115 LC=3,LU
            DO 977 ND=1,2
               DLTRN(LC,ND,MN)=IFIX(10.*DLTRN(LC,ND,MN)+0.5)*0.1
               DBTRN(LC,ND,MN)=IFIX(10.*DBTRN(LC,ND,MN)+0.5)*0.1
  977       CONTINUE
            DLTRN(LC,3,MN)=DLTRN(LC,1,MN)+DLTRN(LC,2,MN)
            DBTRN(LC,3,MN)=DBTRN(LC,1,MN)+DBTRN(LC,2,MN)
            DO 116 ND=1,3
               DT(LC,ND,MN)=DLTRN(LC,ND,MN)+DBTRN(LC,ND,MN)
               TOTDL(ND,MN)=TOTDL(ND,MN)+DLTRN(LC,ND,MN)
               TOTDB(ND,MN)=TOTDB(ND,MN)+DBTRN(LC,ND,MN)
               TOTDT(ND,MN)=TOTDT(ND,MN)+DT(LC,ND,MN)
  116        CONTINUE
  115    CONTINUE
  114 CONTINUE
      DO 117 I=1,13,2
         J=I+3
         IF( J.GT.14 ) J=J-14
         JI=J+1
         IF( JI.EQ.15 ) JI=1
         WRITE(8,121) IBMO(J),IBMO(JI)
         WRITE(8,122)
         DO 223 LC=3,LU
            WRITE(8,224)LC,(DLTRN(LC,K,J),DBTRN(LC,K,J),DT(LC,K,J),
     +       K=1,3),(DLTRN(LC,K,JI),DBTRN(LC,K,JI),DT(LC,K,JI)
     +        ,K=1,3)
  223    CONTINUE
         WRITE(8,225)(TOTDL(K,J),TOTDB(K,J),TOTDT(K,J),K=1,3),
     +    (TOTDL(K,JI),TOTDB(K,JI),TOTDT(K,JI),K=1,3)
         IF( J.NE.8 .AND. J.NE.14 ) GOTO 119
            IF( IS.NE.1 ) WRITE(8,128)
C
            CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
            WRITE(8,113)
            WRITE(8,118)
  119    CONTINUE
  117 CONTINUE
      WRITE(8,123)
      IF(IS.NE.1) WRITE(8,126)
      DO 226 MN=1,14
         DO 227 LC=4,LU
            HOLD=DLTRN(LC,1,MN)
            DLTRN(LC,1,MN)=DLTRN(LC,2,MN)
            DLTRN(LC,2,MN)=HOLD
            HOLD=DBTRN(LC,1,MN)
            DBTRN(LC,1,MN)=DBTRN(LC,2,MN)
            DBTRN(LC,2,MN)=HOLD
  227    CONTINUE
  226 CONTINUE
C
C ***** ACTUAL TRANSITS TABLE *****
C ***** QUEUING INFORMATION TABLE
C ***** MONTHLY DELAY COST TABLE ***
C ***** ACTUAL CARGO FLOW TABLE ****
C
                  IF( IS.EQ.1 )CALL ACTRAN(LU,IS,INUMB,IR,ISN,
     +               ILTML)
                  IF( IS.NE.1 )CALL ACTRN2(LU,IS,INUMB,IR,ISN,
     +               ILTML,SORTOT)
                  CALL QUETAB (IS,INUMB,IR,ISN,ILTML,
     +               SORTUL,SORTOT,LU)
                  CALL ACCARG(CARF,IR)
```

```
C
 7552 CONTINUE
      RETURN
      END
C
C ************************************************************
C
      SUBROUTINE PROJCR (IS,INUMB,IR,ISN,ILTML,CARF)
C
      IMPLICIT INTEGER (I)
      DIMENSION CARF(3,15,80)
C
C
C  SUBPROGRAM PROJCR PRINTS THE PROJECTED CARGO FLOW TABLES
C
      COMMON /HEDCOM/ IBMU(14),IYR(80)
      COMMON /PRJCOM/ IPCARG(3,15,15),PCARG(3,15,6)
C
      INTEGER IPCTOT(3,15)
C
  501 FORMAT (39X,33H**** PROJECTED CARGO TONNAGE ****,/
     + 45X,21H(THOUSAND SHORT TONS)//)
  120 FORMAT (8X,5(14X,A8))
  110 FORMAT (11X,5(4X,17H UP   DOWN  TOTAL,1X))
  702 FORMAT (1X,10HWHEAT     ,4(3I7,1X),3I7/,
     +  1X,10HSOY BEANS ,4(3I7,1X),3I7/,
     +  1X,10HBARLEY+RYE,4(3I7,1X),3I7/,
     +  1X,10HCORN       ,4(3I7,1X),3I7/,
     +  1X,10HOIL SEED   ,4(3I7,1X),3I7/,
     +  1X,10HLIMESTONE  ,4(3I7,1X),3I7/,
     +  1X,10HIRON ORE   ,4(3I7,1X),3I7/,
     +  1X,10HCOAL       ,4(3I7,1X),3I7/,
     +  1X,10HRAW MATL   ,4(3I7,1X),3I7/,
     +  1X,10HPETROLEUM  ,4(3I7,1X),3I7/,
     +  1X,10HCEMENT     ,4(3I7,1X),3I7/,
     +  1X,10HMINERALS   ,4(3I7,1X),3I7/,
     +  1X,10HDRY BULK   ,4(3I7,1X),3I7/,
     +  1X,10HGEN CARGO  ,4(3I7,1X),3I7/,
     +  1X,10HSTEEL PROD,4(3I7,1X),3I7)
  703 FORMAT (11X,4(3(7H-------)1X),3(7H-------))
  704 FORMAT (1X,10HTOTALS     ,4(3I7,1X),3I7//)
  705 FORMAT (8X,4(14X,A8),11X,4HYEAR)
 2295 FORMAT (5(/))
C
      WRITE (8,2295)
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
      DO 20 MN=1,15
         DO 21 ND=1,3
            DO 22 MC= 1,15
               IPCARG(ND,MN,MC)= 0
   22       CONTINUE
            IPCTOT(ND,MN)= 0
   21    CONTINUE
   20 CONTINUE
      DO 2299 ND= 1,3
         DO 2301 MN= 1,14
            DO 8810 MC= 1,5
               IPCARG(ND,MN,MC)= CARF(ND,MC,IR)* PCARG(ND,MN,4)
     +           + 0.5
 8810       CONTINUE
               IPCARG(ND,MN,6)= CARF(ND,6,IR)* PCARG(ND,MN,3)
     +           + 0.5
               IPCARG(ND,MN,7)= CARF(ND,7,IR)* PCARG(ND,MN,1)
     +           + 0.5
               IPCARG(ND,MN,8)= CARF(ND,8,IR)* PCARG(ND,MN,2)
     +           + 0.5
            DO 8820 MC= 9,13
               IPCARG(ND,MN,MC)= CARF(ND,MC,IR)* PCARG(ND,MN,5)
     +           + 0.5
 8820       CONTINUE
            DO 8830 MC= 14,15
               IPCARG(ND,MN,MC)= CARF(ND,MC,IR)*PCARG(ND,MN,6)
     +           + 0.5
 8830       CONTINUE
            DO 8840 MC= 1,15
               IPCARG(ND,15,MC)= IPCARG(ND,15,MC)+ IPCARG(ND,MN,MC)
            IPCTOT(ND,MN)= IPCTOT(ND,MN)+ IPCARG(ND,MN,MC)
 8840       CONTINUE
 2301    CONTINUE
         DO 8850 MC= 1,15
            IPCTOT(ND,15)= IPCTOT(ND,15)+ IPCARG(ND,15,MC)
 8850    CONTINUE
 2299 CONTINUE
```

```
      WRITE(8,501)
      WRITE(8,120) (IBMO(I),I=4,8)
      WRITE(8,110)
      WRITE(8,702)(((IPCARG(I,J,K),I=1,3),J=4,8),K=1,15)
      WRITE(8,703)
      WRITE(8,704)((IPCTOT(I,J),I=1,3),J=4,8)
      WRITE(8,120) (IBMO(I),I=9,13)
      WRITE(8,110)
      WRITE(8,702)(((IPCARG(I,J,K),I=1,3),J=9,13),K=1,15)
      WRITE(8,703)
      WRITE(8,704)((IPCTOT(I,J),I=1,3),J=9,13)
      WRITE(8,705) IBMO(14), (IBMO(I),I=1,3)
      WRITE(8,110)
      WRITE(8,702)(((IPCARG(I,14,K),I=1,3),((IPCARG(I,J,K),I=1,3),
     + J=1,3),(IPCARG(I,15,K),I=1,3),K=1,15)
      WRITE(8,703)
      WRITE(8,704)(IPCTOT(I,14),I=1,3),((IPCTOT(I,J),I=1,3),J=1,3),
     + (IPCTOT(I,15),I=1,3)
      WRITE(8,2295)
C
      RETURN
      END
C
C ******************************************************************
C
      SUBROUTINE MIX (LU,IS,INUMB,IR,ISN,ILTML,SHIP)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM MIX PRINTS THE FLEET MIX TABLE
C
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     +  EMPTY (6,12),FILL(6,12),FLEETN(6,12),FLUAR(6),HRSTR(6),
     +  PO(80,12),REDFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     +  WDIST(6),ZBHF(12),ADDPCT(6,12),CAPINC(12)
      DIMENSION SHIP(12,6),FSHIP(6),TSHIPS(12)
      DIMENSION SUMSHP(6),ASHIP(6),IPCT(6,12)
C
C
  100 FORMAT (//45X,19H#### FLEET MIX ####,//)
  110 FORMAT(7X,5HCLASS,8X,3HORE,13X,4HCOAL,11X,5HSTONE,
     +  11X,5HGRAIN,11X,6HO BULK,9X,6HGCARGO,/X,5HTOTAL,
     +  /,15X,6(6HNUMBER,2X,5HBUILD,3X),/,15X,6(5HSHIPS,5X,1HX,5X))
  120 FORMAT(8X,12,6(5X,F5.1,3X,I3),5X,F5.1)
  130 FORMAT(4X,7(11X,5H-----),/,7X,6HTOTALS,2X,F5.1,6(11X,
     + F5.1)//)
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
      WRITE(8,100)
      WRITE(8,110)
         DO 976 MC=1,6
            TSHIP(MC)=0
  976    CONTINUE
      DO 992 LC=4,LU
         TSHIPS(LC)=0
         DO 972 MC=1,6
            SHIP(LC,MC)= IFIX(10.0* SHIP(LC,MC)+ 0.5)*0.1
            FSHIPS(LC)=TSHIPS(LC)+SHIP(LC,MC)
            TSHIP(MC)=TSHIP(MC)+SHIP(LC,MC)
            IPCT(MC,LC)= ADDPCT(MC,LC)*100.0+ 0.5
  972    CONTINUE
         WRITE(8,120)LC,(SHIP(LC,J),IPCT(J,LC),J=1,6),TSHIPS(LC)
  992 CONTINUE
      TTSHIP=0
      DO 2236 MC=1,6
         TTSHIP=TTSHIP+TSHIP(MC)
 2236 CONTINUE
      WRITE(8,130)(TSHIP(MC),MC=1,6),FTSHIP
      ADDTSH= 0.0
      DO 9500 MC= 1,6
         SUMSHP(MC)= 0.0
 9500 CONTINUE
      DO 9520 LC= 4,LU
         ALC= LC* 1.0
         DO 9510 MC= 1,6
            SUMSHP(MC)= SUMSHP(MC)+ ALC*SHIP(LC,MC)
 9510    CONTINUE
         ADDTSH= ADDTSH+ ALC*TSHIPS(LC)
 9520 CONTINUE
```

```
      DO 9530 MC= 1,6
         IF (TSHIP(MC) .EQ. 0.0) ASHIP(MC)= 0.0
         IF (TSHIP(MC) .EQ. 0.0) GO TO 9530
         ASHIP(MC)= SUMSHP(MC)/TSHIP(MC)
 9530 CONTINUE
      ATSHIP= ADDTSH/ TTSHIP
      WRITE (8,9540) (ASHIP(MC),MC=1,6),ATSHIP
 9540 FORMAT (1X,9HCOMPOSITE,/,1X,10HSHIP CLASS,5X,F4.1,6(12X,F4.1)//)
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE VESCHR (IS,LU,LMIN,LMAX)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM VESCHR PRINTS THE VESSEL CHARACHTERISTICS TABLE
C
      DIMENSION LMIN(12),LMAX(12)
C
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + TMLOCK(12,2,4),VSA(14,12,4)
      COMMON /MINARY/ BASEFT(6,12),CC(6,12),DFA(14,4),DISTN(2,6),
     + EMPTY(6,12),FILL(6,12),FLEETN(6,12),FLOAD(6),HRSYR(6),
     + PO(80,12),REIMFT(12),TDF(12,14),TRIPYR(6,12),VSM(12,6),
     + WDIST(6),ZBMF(12),ADDPCT(6,12),CAPINC(12)
      COMMON /DAT1/ BTF(14,4),CAREX1(6,2,80),CAREX2(6,2,80),
     + DATN(14),DIN(14,4),DIST(6),
     + EXTP1(6,2,80),EXTP2(6,2,80),
     + IZBH(12),LYEAR(80),ODAYS(12),PCRF(14,2),SCOST(12),STDEV(12,2,4),
     + TLTML2(12,2,4),TLTML3(12,2,4),TURNBK(4),UNLOAD(12),XCAP(12),
     + XSHIP(12),ZB(12),GBAL(12),GLOAD(12)
C
    5 FORMAT (1X)
  302 FORMAT(6(/),38X,32H#### VESSEL CHARACTERISTICS ####)
  304 FORMAT(25X,6HVESSEL,9X,4HMEAN,6X,7HMAXIMUM,39X,8HCAPACITY)
  306 FORMAT(15X,6HVESSEL,4X,6HLENGTH,8X,6HVESSEL,5X,8HCARRYING,9X,
     + 6HVESSEL,8X,7HLOCKING,8X,8HINCREASE)
  310 FORMAT(26X,4H(FT),9X,5H(MPH),6X,8H(S.TONS),10X,3H(%),10X,
     + 6H (MIN),10X,7H(ST/IN))
  308 FORMAT(15X,5HCLASS,5X,5HRANGE,9X,5HSPEED,6X,8HCAPACITY,7X,
     + 11HUTILIZATION,6X,4HTIME,9X,10HWITH DRAFT)
  312 FORMAT(22X,11HMIN      MAX,47X,9HUP      DN)
  314 FORMAT(15X,3H  3,4X,32H (PLEASURE CRAFT, NON-COMMERCIAL,
     + 28H VESSELS, AND ICE LOCKAGES) )
  320 FORMAT(16X,I2,3X,I4,4X,I4,6X,F5.1,5X,I7,11X,I3,8X,I4,3X,
     + I4,8X,F5.1)
  332 FORMAT(/15X,36HCLASS 5 IS LAKERS OF CLASSES 5 AND 6)
  334 FORMAT(15X,30HCLASS 6 IS OCEAN GOING VESSELS)
 3334 FORMAT (15X,46HCLASSES 8 AND 9 ARE BOTH LAKER AND OCEAN GOING,
     +  8H VESSELS,//)
  748 FORMAT(//)
 2296 FORMAT (6(/))
C
      WRITE(8,302)
      WRITE(8,5)
      WRITE(8,304)
      WRITE(8,306)
      WRITE(8,308)
      WRITE(8,310)
      WRITE(8,312)
      WRITE(8,314)
      DO 330 LC=4,LU
         ICCC=CC(1,LC)+0.5
         ITMLK1=TMLOCK(LC,2,2)+0.5
         ITMLK2=TMLOCK(LC,1,2)+0.5
         WRITE(8,320)LC,LMIN(LC),LMAX(LC),VSM(LC,1),ICCC,IZBH(LC),
     +    ITMLK1,ITMLK2,CAPINC(LC)
  330 CONTINUE
      WRITE(8,332)
      WRITE(8,334)
      IF (IS .NE. 1 .AND. LU .GE. 12) WRITE (8,3334)
      WRITE(8,748)
      WRITE(8,2296)
C
      RETURN
      END
C
```

```
C
      SUBROUTINE ACTRAN (LU,IS,INUMB,IR,ISN,ILTML)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM ACTRAN PRINTS THE ACTUAL TRANSITS
C  FOR THE SOO LOCK SYSTEM
C
      COMMON /MEDCOM/ IBMO(14),IYR(80)
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
C
      DIMENSION SORTOT(24)
      DIMENSION SORTOL(12,14)
C
C
 2221 FORMAT (43X,25H#### ACTUAL TRANSITS ####)
 2297 FORMAT (50X,9HCONTINUED)
 2215 FORMAT(/,27X,A8,43X,A8)
 2216 FORMAT(5X,2(5X,9HMACARTHUR,10X,3HPOE,9X,15HSABIN AND DAVIS),/,
     + 1X,5HCLASS,6(17H  UP    DN  TOTAL ))
 2218 FORMAT(1X,I2,2X,6(1X,2(1X,F4.1),1X,F5.1))
 2219 FORMAT(5X,6(1X,2(1X,4H----),1X,5H-----),/,
     + 1X,6HTOTAL ,6(2(F4.1,X),F5.1,2X))
   12 FORMAT (12(/))
  991 FORMAT (/,52X,A8)
  993 FORMAT (31X,5HSABIN,11X,9HMACARTHUR,11X,3HPOE,11X,9HNEW DAVIS,
     +  /,21X,5HCLASS,4(1/H  UP    DN  TOTAL ))
  994 FORMAT (5X,2(5X,9HMACARTHUR,10X,3HPOE,12X,9HNEW DAVIS),/,
     +  1X,5HCLASS,6(17H  UP    DN  TOTAL ))
  995 FORMAT (22X,I2,1X,4(1X,2(1X,F4.1),1X,F5.1))
  996 FORMAT (27X,4(2(1X,4H----),1X,5H-----,1X),/,20X,5HTOTAL,1X,
     +   4(2(F4.1,X),F5.1,2X))
C
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
      WRITE(8,2221)
      J= 4
  998 IF (J .GT. 14) J= J-14
      J1= J+1
      IF (J1 .EQ. 15) J1= 1
         DO 76 K=1,24
            SORTOT(K)=0.0
   76    CONTINUE
  992 IF (LU .EQ. 11) WRITE (8,991) IBMO(J)
      IF (LU .NE. 11) WRITE (8,2215) IBMO(J),IBMO(J1)
      IF (LU .LE. 10) WRITE (8,2216)
      IF (LU .EQ. 11) WRITE (8,993)
      IF (LU .GE. 12) WRITE (8,994)
      DO 2217 LC= 3,LU
         IF (LU .EQ. 11) WRITE (8,995) LC,(SOR(M,LC,J),M=1,12)
         IF (LU .LE. 10) WRITE (8,2218) LC,(SOR(M,LC,J),M=1,9),
     +     (SOR(M,LC,J1),M=1,9)
         IF (LU .GE. 12) WRITE (8,2218) LC,(SOR(M,LC,J),M=4,12),
     +     (SOR(M,LC,J1),M=4,12)
         DO 75 K= 1,12
            IF (LU .LE. 10 .AND. K .GE. 10) GO TO 75
            IF (LU .GE. 12 .AND. K .LE. 3) GO TO 75
            SORTOT(K)= SORTOT(K)+SOR(K,LC,J)
            IF (LU .EQ. 11) GO TO 75
            SORTOT(K+12)= SORTOT(K+12)+SOR(K,LC,J1)
   75    CONTINUE
 2217 CONTINUE
      IF (LU .LE. 10) WRITE (8,2219) (SORTOT(K),K=1,9),(SORTOT(K),
     +  K=13,21)
      IF (LU .EQ. 11) WRITE (8,996) (SORTOT(K),K=1,12)
      IF (LU .GE. 12) WRITE (8,2219) (SORTOT(K),K=4,12),(SORTOT(K),
     +  K=16,24)
      IF (LU .NE. 11 .AND. J .NE. 8 .AND. J .NE. 14) GO TO 15
      IF (LU .EQ. 11 .AND. J .NE. 6 .AND. J .NE. 9 .AND. J .NE. 12
     +  .AND. J .NE. 1) GO TO 15
C
         CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
         WRITE(8,2221)
         WRITE(8,2297)
   15    CONTINUE
      J= J+2
      IF (LU .EQ. 11) J= J1
      IF (LU .EQ. 11 .AND. J1 .EQ. 4) GO TO 2214
      IF (LU .NE. 11 .AND. J .EQ. 4) GO TO 2214
      GO TO 998
```

```
 2214 CONTINUE
      WRITE(8,12)
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE ACTRN2 (LU,IS,INUMB,IR,ISN,ILTML,
     +  SORTOT)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM ACTRN2 PRINTS THE ACTUAL TRANSITS
C  FOR THE WELLAND AND SEAWAY
C
      COMMON /HEDCOM/ IBMO(14),IYR(80)
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
C
      DIMENSION SORTOT(3,14)
C
C
  110 FORMAT (43X,25H#### ACTUAL TRANSITS ####)
  120 FORMAT (/6X,5(6X,A9,8X),/,
     + 1X,5HCLASS,5(3X,2HUP,4X,2HDN,2X,5HTOTAL,4X))
  130 FORMAT (/6X,4(6X,A9,8X),/,
     + 1X,5HCLASS,4(3X,2HUP,4X,2HDN,2X,5HTOTAL,4X))
    2 FORMAT (3X,I2,1X,5(3(F4.1,3X),1X))
    4 FORMAT (6X,5(3(4H----,3X),1X),/,
     + 1X,5HTOTAL,5(3(F4.1,3X),1X))
   12 FORMAT (6X,4(3(4H----,3X),1X),/,
     + 1X,5HTOTAL,4(3(F4.1,3X),1X))
  170 FORMAT(5(/))
C
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
C
      WRITE(8,110)
      WRITE(8,120) (IBMO(I),I=4,8)
      DO 100 LC=4,LU
         WRITE(8,2)LC,((SOR(I,LC,J),I=1,3),J=4,8)
  100 CONTINUE
      WRITE(8,4)((SORTOT(ND,MN),ND=1,3),MN=4,8)
      WRITE(8,120) (IBMO(I),I=9,13)
      DO 200 LC=4,LU
         WRITE(8,2) LC,((SOR(I,LC,J),I=1,3),J=9,13)
  200 CONTINUE
      WRITE(8,4)((SORTOT(ND,MN),ND=1,3),MN=9,13)
      WRITE(8,130) IBMO(14), (IBMO(I),I=1,3)
      DO 300 LC=4,LU
         WRITE(8,2)LC,(SOR(I,LC,14),I=1,3),((SOR(I,LC,J),
     +     I=1,3),J=1,3)
  300 CONTINUE
      WRITE(8,12)(SORTOT(ND,14),ND=1,3),((SORTOT(ND,MN),ND=1,3),
     + MN=1,3)
      WRITE(8,170)
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE QUETAB (IS,INUMB,IR,ISN,ILTML,
     +  SORTOL,SORTOT,LU)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM QUETAB PRINTS THE QUEUEING AND LOCKING TIME INFORMATION
C
      COMMON /HEDCOM/  IBMO(14),IYR(80)
      COMMON /CALCOM/ ADDTRN(6,12,2),CARGOP(6,2,80),
     + CTRAN(6,12,4),CTRNPM(6,12,2),EXTPT(6,2,80),HRS(14,4,6),
     + IMLOCK(12,2,4),VSA(14,12,4)
      COMMON /QUECOM/ CAGOCL(6,12),DBTRN(12,3,14),DLTRN(12,3,14),
     + DM(14),DT(12,3,14),IDBTRN(12,3),ICTRNP(6,12,2),IDLTRN(12,3),
     + IHRS(14),ILTR(3,12),IRHO(4,14),ISDEV(4,2,14),ISYSTM(14),
     + ITLTR(3,12),ITMCST(15,12,4),ITMCYC(4,2,14),IVOT(3,3),
     + ITOTC(2,6),IVOST(12,3),QUE(4,2,14),TOTDB(3,14),TOTDL(3,14),
     + TOTDT(3,14),WTQM(4,2,14),XDBTRN(12,2),XDLTRN(12,2)
C
      DIMENSION IWAITM(4,2,14)
      DIMENSION SORTOL(12,14),SORTOT(3,14),WAITC(4,2),WAITM(4,2,14)
C
```

```
    5 FORMAT (1X)
 2145 FORMAT (41X,29H#### QUEUING INFORMATION ####)
 2171 FORMAT (48X,17HCONSTRAINING LOCK)
 2146 FORMAT (31X,7(3X,A9),/,30X,7(4X,2HUP,4X,2HDN))
 2149 FORMAT (1X,26HLOCK OPERATION TIME (HRS) ,7(6X,I6))
 2191 FORMAT (1X,29HLOCK CYCLE TIME (MIN): MEAN  ,7(2(1X,I5)))
 2192 FORMAT (1X,29H                        : ST DEV,7(2(1X,I5)))
 2193 FORMAT (1X,29HAVE.WAITING TIME (HOURS)     ,7(2(1X,F5.2)))
 2194 FORMAT (1X,29HAVE. QUEUE LENGTH (SHIPS)    ,7(2(1X,F5.2)))
 2195 FORMAT (1X,26HLOCK UTILIZATION (%)      ,7(6X,I6))
 2150 FORMAT (//43X,24HREMAINING LOCKS _ SYSTEM)
 2151 FORMAT (1X,21HSYSTEM ROUNDTRIP TIME,5X,7(6X,I6),/
     + 1X,22H  _ WAITING TIME (HRS))
  127 FORMAT (5(/))
C
      CALL HEADER (IS,INUMB,IR,ISN,ILTML)
      DO 2319 I=1,14
         IHRS(I)=HRS(I,ISN,1)+0.5
 2319 CONTINUE
      WRITE(8,2145)
      IKNT1=0
      IF (IS .EQ. 1 .AND. LU .GE. 12) IKNT1= 1
 2180 IKNT1=IKNT1+1
      DO 500 I=1,3
       DO 500 J=1,2
          WAITC(I,J)=0.0
        DO 500 K=1,14
            WAITM(I,J,K)=0.0
           IWAITM(I,J,K)=0
  500 CONTINUE
      IF( IS.NE.1 ) WRITE(8,2171)
      IF( IS.EQ.1 ) CALL QUEUE(IKNT1,LU)
C
C  CONSTRAINING LOCK
C
      WRITE(8,2146) (IBMO(I),I=4,10)
      WRITE(8,2149)(IHRS(I),I=4,10)
      WRITE(8,2191)(ITMCYC(IKNT1,2,I),ITMCYC(IKNT1,1,I),I=4,10)
      WRITE(8,2192)(ISDEV(IKNT1,2,I),ISDEV(IKNT1,1,I),I=4,10)
      WRITE(8,2193)(WTQM(IKNT1,2,I),WTQM(IKNT1,1,I),I=4,10)
      IF (IS .EQ. 1) GO TO 3000
      DO 3001 K= 1,2
         DO 3002 I= 1,14
            WAITM(IKNT1,K,I)= WTQM(IKNT1,K,I)* SORTOT(K,I)* DM(I)
            WAITC(IKNT1,K)= WAITC(IKNT1,K)+ WAITM(IKNT1,K,I)
 3002    CONTINUE
 3001 CONTINUE
      GO TO 3004
 3000 DO 3005 K= 1,2
      IF(K.EQ.1) KS=2
      IF(K.EQ.2) KS=1
      K1=(IKNT1-1)*3+KS
         DO 3006 I= 1,14
            WAITM(IKNT1,K,I)= WTQM(IKNT1,K,I)* SORTOL(K1,1)* DM(I)
            WAITC(IKNT1,K)= WAITC(IKNT1,K)+ WAITM(IKNT1,K,I)
 3006    CONTINUE
 3005 CONTINUE
 3004 DO 3021 K=1,2
      DO 3022 I=1,14
      IWAITM(IKNT1,K,I)=WAITM(IKNT1,K,I)+0.5
 3022 CONTINUE
 3021 CONTINUE
      WRITE(8,3007) (IWAITM(IKNT1,2,I),
     +  IWAITM(IKNT1,1,I),I=4,10)
 3007 FORMAT(1X,29HMONTHLY WAITING TIME (HRS)   ,7(2I6))
      WRITE(8,2194)(QUE(IKNT1,2,I),QUE(IKNT1,1,I),I=4,10)
      WRITE(8,2195)(IRHO(IKNT1,I),I=4,10)
      WRITE(8,2146) (IBMO(I),I=11,14), (IBMO(I),I=1,3)
      WRITE(8,2149)(IHRS(I),I=11,14),(IHRS(I),I=1,3)
      WRITE(8,2191)(ITMCYC(IKNT1,2,I),ITMCYC(IKNT1,1,I),I=11,14),
     + (ITMCYC(IKNT1,2,I),ITMCYC(IKNT1,1,I),I=1,3)
      WRITE(8,2192)(ISDEV(IKNT1,2,I),ISDEV(IKNT1,1,I),I=11,14),
     + (ISDEV(IKNT1,2,I),ISDEV(IKNT1,1,I),I=1,3)
      WRITE(8,2193)(WTQM(IKNT1,2,I),WTQM(IKNT1,1,I),I=11,14),
     + (WTQM(IKNT1,2,I),WTQM(IKNT1,1,I),I=1,3)
      WRITE(8,3007) (IWAITM(IKNT1,2,I),
     +  IWAITM(IKNT1,1,I),I=11,14),(IWAITM(IKNT1,2,I),IWAITM(
     +  IKNT1,1,I),I=1,3)
      WRITE(8,2194)(QUE(IKNT1,2,I),QUE(IKNT1,1,I),I=11,14),
     + (QUE(IKNT1,2,I),QUE(IKNT1,1,I),I=1,3)
      WRITE(8,2195)(IRHO(IKNT1,I),I=11,14),
     + (IRHO(IKNT1,I),I=1,3)
      WRITE(8,3008) WAITC(IKNT1,2),WAITC(IKNT1,1)
```

```
 3000 FORMAT(/,1X,29HYEARLY WAITING TIME (HOURS)  ,7X,8HUPBOUND:,
     +  1X,F6.0,7X,10HDOWNBOUND:,1X,F6.0)
      IF( IS.NE.1 )GOTO 2181
         IF( IKNT1.LE.2 ) GOTO 2180
      IF (LU .GE. 11 .AND. IKNT1 .LE. 3) GO TO 2180
            GOTO 2182
C
C  NON-CONSTRAINING LOCKS
C
 2181 CONTINUE
         WRITE(8,2150)
         WRITE(8,2146) (IBMO(I),I=4,10)
         WRITE(8,2149)(IHRS(I),I=4,10)
         WRITE(8,2191)(ITMCYC(2,2,I),ITMCYC(2,1,I),I=4,10)
         WRITE(8,2192)(ISDEV(2,2,I),ISDEV(2,1,I),I=4,10)
         WRITE(8,2193)(WTQM(2,2,I),WTQM(2,1,I),I=4,10)
         WRITE(8,2194)(QUE(2,2,I),QUE(2,1,I),I=4,10)
         WRITE(8,2195)(IRHO(2,I),I=4,10)
         WRITE(8,2151)(ISYSTM(I),I=4,10)
         WRITE(8,2146) (IBMO(I),I=11,14), (IBMO(I),I=1,3)
         WRITE(8,2149)(IHRS(I),I=11,14),(IHRS(I),I=1,3)
         WRITE(8,2191)(ITMCYC(2,2,I),ITMCYC(2,1,I),I=11,14),
     +    (ITMCYC(2,2,I),ITMCYC(2,1,I),I=1,3)
         WRITE(8,2192)(ISDEV(2,2,I),ISDEV(2,1,I),I=11,14),
     +    (ISDEV(2,2,I),ISDEV(2,1,I),I=1,3)
         WRITE(8,2193)(WTQM(2,2,I),WTQM(2,1,I),I=11,14),
     +    (WTQM(2,2,I),WTQM(2,1,I),I=1,3)
         WRITE(8,2194)(QUE(2,2,I),QUE(2,1,I),I=11,14),
     +    (QUE(2,2,I),QUE(2,1,I),I=1,3)
         WRITE(8,2195)(IRHO(2,I),I=11,14),
     +    (IRHO(2,I),I=1,3)
         WRITE(8,2151)(ISYSTM(I),I=11,14),(ISYSTM(I),I=1,3)
 2182 CONTINUE
      WRITE(8,127)
C
      RETURN
      END
C
C ***************************************************************************
C
      SUBROUTINE ACCARG(CARF,IR)
C
      IMPLICIT INTEGER (I)
C
C
C  SUBPROGRAM ACCARG PRINTS THE ACTUAL CARGO FLOW TABLE
C
      COMMON /CARGCM/ CAGOCM(6,14),SOR(12,12,14)
      COMMON /PRJCOM/ IPCARG(3,15,15),PCARG(3,15,6)
C
      DIMENSION CARF(3,15,80)
      DIMENSION ITFLOW(15),ICAGO(15,14),ICAG(15)
C
      INTEGER  ICFLOW(15)
C
      DATA ICAG / 8HWHEAT   ,8HSOY BEAN,8HBAR+RYE ,
     +  8HCORN    ,8HOIL SEED,8HLIMESTN ,8HIRON ORE,
     +  8HCOAL    ,8HRAW MATL,8HPETROL  ,8HCEMENT  ,
     +  8HMINERAL ,8HDRY BULK,8HGEN CARG,8HSTL PROD /
C
    1 FORMAT (4(/),37X,40HACTUAL CARGO FLOW BY COMMODITY AND MONTH)
    2 FORMAT(3X,53HCARGO      1 APR  2 APR    MAY    JUNE    JULY     AUG   ,
     + 42HSEPT     OCT     NOV  1 DEC  2 DEC    JAN     ,
     + 18HFEB    MARCH   TOTAL,)
    4 FORMAT(1X,A10,1X,14(I6,1X),I7)
    5 FORMAT(12X,14(6H------,1X),7H-------,/,
     + 5X,7HTOTAL   ,14(I6,1X),I7)
   11 FORMAT (2X,37HCARGO FLOW CAPACITY HAS BEEN REACHED!,/,
     + 2X,41HCARGO FLOW PROJECTION CAN NOT BE REACHED.)
C
      DO 12 IA=1,15
         ITFLOW(IA)=0
         ICFLOW(IA)=0
   12 CONTINUE
      WRITE(8,1)
      WRITE(8,2)
      DO 6 MN= 1,14
         DO 7 MC= 1,5
            ICAGO(MC,MN)= CARF(3,MC,IR)* CAGOCM(4,MN)+ 0.5
    7    CONTINUE
            ICAGO(6,MN)= CARF(3,6,IR)* CAGOCM(3,MN)+ 0.5
            ICAGO(7,MN)= CARF(3,7,IR)* CAGOCM(1,MN)+ 0.5
            ICAGO(8,MN)= CARF(3,8,IR)* CAGOCM(2,MN)+ 0.5
```

```
      DO 9060 MC= 9,13
         ICAGO(MC,MN)= CARF(3,MC,IR)* CAGOCM(5,MN)+ 0.5
 9060 CONTINUE
      DO 9070 MC= 14,15
         ICAGO(MC,MN)= CARF(3,MC,IR)* CAGOCM(6,MN)+ 0.5
 9070 CONTINUE
    6 CONTINUE
      DO 9071 MC= 1,15
         DO 9090 MN= 1,14
            ITFLOW(MC)= ITFLOW(MC)+ ICAGO(MC,MN)
 9090 CONTINUE
      WRITE(8,4)ICAG(MC),(ICAGO(MC,MN),MN=4,14),(ICAGO(MC,MN),
     +    MN=1,3),ITFLOW(MC)
 9071 CONTINUE
      DO 9600 MN= 1,14
         DO 9601 MC= 1,15
            ICFLOW(MN)= ICFLOW(MN)+ ICAGO(MC,MN)
 9601 CONTINUE
      ICFLOW(15)= ICFLOW(15)+ ICFLOW(MN)
 9600 CONTINUE
      WRITE(8,5) (ICFLOW(I),I=4,14),(ICFLOW(I),I=1,3),ICFLOW(15)
   14 CONTINUE
      WRITE (8,2488)
 2488 FORMAT (4(/))
C
      RETURN
      END
```

APPENDIX C

DATA FILE LISTING

SOO DATA FILE

```
1,1                 GONOGO, DATA FILE IDENTIFIER
10                  MAXIMUM VESSEL CLASS
1,0,0,0             SEASON EXTENSIONS
1,0,0               LOCKING TIMES (NORMAL, LOW, HIGH)
0.80,0.80,0.80,0.80,0.80,0.80,0.80,0.80,0.80,0.80,0.80     SHIP UTILIZATION FACTORS
1.00,1.00,00.00,00.00,00.00,00.00,00.00,00.00,00.00,00.00  FACTOR, CALFAC
FLEET MIX SHIP BUILDING FACTORS
ORE   COAL  STONE GRAIN UBULK UCARGO    CLASS
0.00  0.00  0.00  0.00  0.30  0.20        4
0.10  0.10  0.40  0.10  0.60  0.00        5
0.00  0.05  0.00  0.20  0.00  0.80        6
0.20  0.40  0.60  0.70  0.10  0.00        7
0.10  0.15  0.00  0.00  0.00  0.00        8
0.00  0.00  0.00  0.00  0.00  0.00        9
0.60  0.30  0.00  0.00  0.00  0.00       10
CARRYING CAPACITY BY SHIP CLASS (IN SHORT TONS)
   4      5      6      7      8      9      10
09500. 21000. 15000. 27000. 28000. 45000. 60000.          IRON ORE - STONE
08700. 14000. 15000. 21000. 24000. 28000. 60000.          COAL - GRAIN
08700. 14000. 15000. 21000. 24000. 28000. 60000.          BULK - GENERAL CARGO
VALIDATION TRANSIT DISTRIBUTION FACTORS
  JAN  FEB  MAR  APR  APR  MAY  JUN  JLY  AUG  SEP  OCT  NOV  DEC  DEC
 .007 .000 .000 .023 .048 .120 .127 .131 .123 .131 .127 .101 .037 .025
 .007 .000 .000 .023 .048 .120 .127 .131 .123 .131 .127 .101 .037 .025
 .007 .000 .000 .023 .048 .120 .127 .131 .123 .131 .127 .101 .037 .025
CARGO PROJECTIONS  #### 1978 ####   (SHORT TONS / YEAR)
DOWNBOUND
17401.  135.    3430.   1609.   1282.   0.0     67699.  76.     2846.   141.
1.      41.     1702.   576.    257.
                #### 1978 ####
UPBOUND
0.0     0.0     0.0     0.0     0.0     1995.   178.    42.     4817.   1064.
807.    459.    83.     690.    46.
                #### 1985 ####
DOWNBOUND
22917.  62.     5084.   1408.   1298.   0.      73007.  81.     4685.   151.
1.      49.     1900.   623.    284.
                #### 1985 ####
UPBOUND
0.      0.      0.      0.      0.      2060.   197.    48.     6551.   1149.
948.    504.    101.    742.    91.
                #### 1990 ####
DOWNBOUND
25731.  66.     6566.   1211.   1311.   0.      80554.  97.     11702.  158.
1.      55.     2042.   659.    299.
                #### 1990 ####
UPBOUND
0.      0.      0.      0.      0.      2307.   224.    52.     5418.   1199.
1051.   537.    114.    781.    73.
                #### 2000 ####
DOWNBOUND
25171.  73.     7559.   1139.   1337.   0.      90495.  113.    17338.  174.
2.      70.     2376.   739.    330.
                #### 2000 ####
UPBOUND
0.      0.      0.      0.      0.      2543.   254.    61.     6858.   1306.
1338.   618.    148.    867.    76.
                #### 2010 ####
DOWNBOUND
27033.  77.     8407.   1244.   1364.   0.      104196. 134.    19749.  192.
2.      87.     2758.   827.    365.
                #### 2010 ####
UPBOUND
0.      0.      0.      0.      0.      2884.   292.    71.     7511.   1423.
1676.   709.    185.    961.    94.
                #### 2020 ####
DOWNBOUND
28978.  79.     9167.   1371.   1391.   0.      118656. 159.    17951.  211.
2.      110.    3202.   927.    399.
                #### 2020 ####
UPBOUND
0.      0.      0.      0.      0.      3302.   332.    82.     8238.   1553.
2098.   817.    231.    1066.   75.
                #### 2030 ####
DOWNBOUND
31635.  80.     9926.   1497.   1419.   0.      134166. 188.    17991.  233.
2.      140.    3718.   1039.   443.
                #### 2030 ####
UPBOUND
0.      0.      0.      0.      0.      3780.   375.    96.     9045.   1698.
2627.   945.    289.    1183.   120.
                #### 2040 ####
```

```
DOWNBOUND
34301.  82.     10687.  1620.   1448.   0.      150710. 224.    18036.  257.
2.      180.    4317.   1164.   491.
                ####  2040  ####
UPBOUND
0.      0.      0.      0.      0.      4328.   425.    111.    9942.   1858.
3291.   1097.   361.    1313.   157.
                ####  2050  ####
DOWNBOUND
36894.  84.     12207.  1769.   1462.   0.      166055. 266.    18085.  283.
3.      234.    5018.   1305.   543.
                ####  2050  ####
UPBOUND
0.      0.      0.      0.      0.      4955.   478.    129.    10939.  2035.
4123.   1279.   451.    1456.   195.
HOURS AVAILABLE FOR LOCKING OPERATIONS BY MONTH
 JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG SEPT  OCT  NOV  DEC  DEC
23.8 23.9 23.9 23.7 23.7 23.7 23.8 23.9 24.0 23.8 23.8 23.9 23.9 23.9
LOCKING TIME IN MINUTES BY SHIP CLASS
  4     5     6     7     8     9    10          SHIP CLASS
0039. 0042. 0042. 0045. 0048. 0000. 0000.        DOWN   FOR SABIN-DAVIS LOCK
0038. 0041. 0042. 0045. 0046. 0000. 0000.        UP
0073. 0075. 0074. 0077. 0078. 0101. 0106.        DOWN   FOR MACARTHUR-POE LOCK
0068. 0065. 0065. 0061. 0068. 0073. 0089.        UP
LOW TIMES
  4     5     6     7     8     9    10          SHIP CLASS
0066. 0074. 0072. 0075. 0077. 0096. 0102.        DOWN   FOR MACARTHUR-POE LOCK
0058. 0063. 0063. 0058. 0067. 0069. 0084.        UP
HIGH TIMES
  4     5     6     7     8     9    10          SHIP CLASS
0080. 0076. 0076. 0079. 0079. 0106. 0110.        DOWN   FOR MACARTHUR-POE LOCK
0078. 0067. 0067. 0064. 0069. 0077. 0094.        UP
LOCKING TIME STANDARD DEVIATION IN MINUTES BY SHIP CLASS
  4     5     6     7     8     9    10          SHIP CLASS
002.8 003.2 002.7 002.8 003.0 000.0 000.0        DOWN   FOR SABIN-DAVIS LOCK
002.5 002.8 004.0 003.5 002.2 000.0 000.0        UP
006.3 006.7 006.2 006.3 003.5 006.3 005.5
009.0 009.3 009.3 009.7 005.3 005.7 007.3
VALIDATION BIAS TRAFFIC FACTORS
E.AP  L.AP  E.DC  L.DC
00.50 00.20 00.60 00.80
TURNBACK TIME IN MINUTES BY LOCK
 MAC   POE   S-D
0000. 0000. 0000.
SHIP COST ($/HOUR) BY SHIP CLASS
  4       5       6       7       8       9      10            SHIP CLASS
000373. 000396. 000423. 000435. 000423. 000553. 000579.       OPERATING COST
000287. 000356. 000397. 000438. 000493. 000630. 000767.       CAPITAL COST
NON-COMMERCIAL CRAFT DAILY ARRIVAL - ICE LOCKAGES
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0
02.0 03.0 03.0 01.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0 00.0   DN
LOADING FACTOR - FLOAD
O   C   S   G    OB   GC
1.0 1.0 1.0 1.0 0.85 .85
ONE WAY DISTANCE (DISTN)
  ORE   COAL  STONE  GRAIN  O BULK G CARGO
00824. 00774. 00790. 01478. 01149. 00875.
00000. 00782. 00549. 00000. 01077. 00782.
LOADING RATE (FILL)
  ORE   COAL  STONE  GRAIN  O BULK G CARGO
02800. 09000. 02800. 01481. 00600. 00150.     4
02800. 09000. 02800. 01481. 00600. 00150.     5
02800. 09000. 02800. 01481. 00600. 00150.     6
02800. 09000. 02800. 01481. 00600. 00150.     7
02800. 09000. 02800. 01481. 00600. 00150.     8
02800. 09000. 02800. 01481. 00600. 00150.     9
02800. 09000. 02800. 01481. 00600. 00150.    10
UNLOADING RATE (EMPTY)
  ORE   COAL  STONE  GRAIN  O BULK G CARGO
02800. 01848. 00700. 01266. 00143. 00150.     4
02800. 01848. 00700. 01266. 00143. 00150.     5
11200. 01848. 06720. 01266. 00143. 00150.     6
11200. 01848. 06720. 01266. 00143. 00150.     7
11200. 06720. 06720. 01266. 00143. 00150.     8
11200. 06720. 06720. 01266. 00143. 00150.     9
11200. 06720. 06720. 01266. 00143. 00150.    10
OPERATING HOURS PER MONTH PER SEASON EXTENSION (HRS)
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. ORE EXT 1
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. COAL
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. STONE
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. GRAIN
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. O BULK
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. G CARGO
```

```
738. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. ORE EXT 2
738. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. COAL
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. STONE
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. GRAIN
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. O BULK
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. G CARGO
738. 669. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. ORE EXT 3
738. 669. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. COAL
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. STONE
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. GRAIN
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. O BULK
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. G CARGO
738. 669. 741. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. ORE EXT 4
738. 669. 741. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. COAL
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. STONE
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. GRAIN
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. O BULK
000. 000. 000. 356. 356. 735. 714. 741. 744. 714. 738. 717. 360. 384. G CARGO
VESSEL SPEED BY MONTH AND CLASS (VSA)
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT NOV  DEC  DEC
00.0 00.0 00.0 13.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.6   4 EXT 1
00.0 00.0 00.0 13.1 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.8   5
00.0 00.0 00.0 13.9 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6   6
00.0 00.0 00.0 14.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6   7
00.0 00.0 00.0 14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8   8
00.0 00.0 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8   9
00.0 00.0 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8  10
11.6 00.0 00.0 13.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.6     EXT 2
12.5 00.0 00.0 13.1 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.8
13.2 00.0 00.0 13.9 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.7 00.0 00.0 14.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.9 00.0 00.0 14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 00.0 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 00.0 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
11.6 09.3 00.0 13.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.6     EXT 3
12.5 10.1 00.0 13.1 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.8
13.2 10.7 00.0 13.9 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.7 11.9 00.0 14.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.9 12.7 00.0 14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 12.7 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 12.7 00.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
11.6 09.3 09.9 13.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.6     EXT 4
12.5 10.1 10.5 13.1 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.8
13.2 10.7 11.1 13.9 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.7 11.9 12.0 14.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.6
13.9 12.0 12.2 14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 12.7 13.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
14.1 12.7 13.0 14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
RELATIVE DEMAND INDEXES (DIN)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
00.0 00.0 00.0 01.8 04.2 10.0 10.0 10.0 10.0 10.0 10.0 10.0 03.2 02.1   EXT 1
06.0 00.0 00.0 01.8 04.2 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT 2
07.0 06.0 00.0 01.8 04.2 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT 3
07.0 07.0 07.0 08.0 09.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT 4
VESSEL RETIREMENT FRACTIONS (PU)
  4    5    6    7    8    9   10              YEAR
0.00 0.00 0.00 0.00 0.00 0.00 0.00              1978
0.56 0.30 0.20 0.00 0.00 0.00 0.00              1985
1.00 0.50 0.30 0.00 0.00 0.00 0.00              1990
1.00 0.80 0.50 0.10 0.20 0.00 0.00              2000
1.00 0.85 0.80 0.20 0.30 0.00 0.00              2010
1.00 0.95 0.85 0.30 0.80 0.00 0.20              2020
1.00 1.00 0.95 0.80 0.92 0.00 0.30              2030
1.00 1.00 1.00 0.85 1.00 1.00 0.50              2040
1.00 1.00 1.00 0.90 1.00 1.00 0.60              2050
BASE YEAR FLEET (BASEFT)
  4     5     6     7     8     9    10
0.00  30.10 0.00  7.50  6.60  1.00  8.00        ORE
1.40  6.30  1.00  0.30  0.00  0.00  1.00        COAL
0.60  0.90  0.00  0.00  0.00  0.00  0.00        STONE
1.40  7.30  6.90  14.60 0.00  0.00  0.00        GRAIN
0.00  1.10  0.00  3.80  0.00  0.00  0.00        O BULK
2.70  0.00  3.80  0.00  0.00  0.00  0.00        G CARGO
BIASED TRAFFIC FACTOR (BTF)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
0.00 0.00 0.00 0.50 0.20 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.60 0.80   EXT 1
0.05 0.00 0.00 0.50 0.20 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.10   EXT 2
0.00 0.05 0.00 0.50 0.20 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.10   EXT 3
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.10   EXT 4
EXTENDED SEASON DISTRIBUTION FRACTIONS
J=1    F=2    M=3
1.0000 0.0000 0.0000       ISN2
0.5000 0.5000 0.0000       ISN3
0.3333 0.3333 0.3333       ISN4
```

```
CAPACITY INCREASE WITH DEPTH (SHORT TONS PER  YEAR)
  4       5       6       7       8       9       10
0.00    91.80   61.80  113.10 115.60 167.10 207.10
1                CAPACITY EXPANSION? 1=YES,0=NO
1                CAPACITY EXPANSION MEASURE
0.075  0.075              LOCKING TIME                    TRAVELING NEVELS
0.025  0.025              REDUCTION FACTORS               INCREASE SHIP SPEED
0.055  0.010                                              FASTER DUMP/FILL
0.045  0.045                                              TRAFFIC CONTROL
0.130  0.130                                              MAXIMUM UTILITY
5                LOCKING TIME REDUCTION SELECTOR
1                CAPACITY EXPANSION?
3                INCREASE ALLOWABLE DRAFT
32.0             NEW DRAFT
0                DEEPER DRAFT AND LARGER SHIPS
0                CAPACITY EXPANSION MEASURE 2
2                BUILD LARGER LOCKS
11               MAXIMUM SHIP SIZE
0.80 0.80           ZBHF
FLEET MIX BUILDING FACTORS
 ORE    COAL  STONE GRAIN OBULK GCARGO
0.00   0.00  0.00  0.00  0.30  0.10            4
0.10   0.05  0.40  0.05  0.60  0.10            5
0.00   0.05  0.00  0.10  0.00  0.30            6
0.00   0.10  0.60  0.50  0.10  0.00            7
0.10   0.05  0.00  0.00  0.00  0.50            8
0.00   0.00  0.00  0.00  0.00  0.00            9
0.60   0.65  0.00  0.60  0.00  0.00           10
0.20   0.10  0.00  0.20  0.00  0.00           11
0.00   0.00  0.00  0.00  0.00  0.00           12
SHIP CARRYING CAPACITIES
  11       12
72000.0 90000.0                                     ORE
72000.0 90000.0                                     COAL
72000.0 90000.0                                     STONE
72000.0 90000.0                                     GRAIN
72000.0 90000.0                                     O BULK
72000.0 90000.0                                     G CARGO
LOCKING TIME (NORMAL)
  4     5     6     7     8     9     10    11    12
73.0  75.0  74.0  77.0  78.0  0.0   0.0   0.0   0.0          DN-SABIN
68.0  65.0  65.0  61.0  68.0  0.0   0.0   0.0   0.0          UP
73.0  75.0  74.0  77.0  78.0  101.0 106.0 115.0 126.0        DN-MACARTHUR,POE,
68.0  65.0  65.0  61.0  68.0  73.0  89.0  98.0  113.0        UP   DAVIS
LOCKING TIMES (LOW)
  4     5     6     7     8     9     10    11    12
73.0  75.0  74.0  77.0  78.0  0.0   0.0   0.0   0.0          DN-SABIN
68.0  65.0  65.0  61.0  68.0  0.0   0.0   0.0   0.0          UP
73.0  75.0  74.0  77.0  78.0  101.0 106.0 115.0 126.0        DN-MACARTHUR,POE,
68.0  65.0  65.0  61.0  68.0  73.0  89.0  98.0  113.0        UP   DAVIS
LOCKING TIMES (HIGH)
  4     5     6     7     8     9     10    11    12
73.0  75.0  74.0  77.0  78.0  0.0   0.0   0.0   0.0          DN-SABIN
68.0  65.0  65.0  61.0  68.0  0.0   0.0   0.0   0.0          UP
73.0  75.0  74.0  77.0  78.0  101.0 106.0 115.0 126.0        DN-MACARTHUR,POE,
68.0  65.0  65.0  61.0  68.0  73.0  89.0  98.0  113.0        UP   DAVIS
LOCKING TIME STANDARD DEVIATION
  4     5     6     7     8     9     10    11    12
6.3   6.7   6.2   6.3   3.5   0.0   0.0   0.0   0.0          DN
9.0   9.3   9.3   9.7   5.3   0.0   0.0   0.0   0.0          UP
6.3   6.7   6.2   6.3   3.5   6.3   5.5   5.1   5.1          DN
9.0   9.3   9.3   9.7   5.3   5.7   7.3   7.3   7.3          UP
LOADING RATES
 ORE    COAL   STONE  GRAIN  OBULK  GCARGO              CLASS
2800.  9000.  2800.  1481.  600.   150.                 11
2800.  9000.  2800.  1481.  600.   150.                 12
UNLOADING RATES
 ORE    COAL   STONE  GRAIN  OBULK  GCARGO              CLASS
11200. 6720.  6720.  1266.  143.   150.                 11
1 1200. 6720.  6720.  1266.  143.   150.                 12
VESSEL SPEED
JAN  FEB  MAR  1APR 2APR MAY  JUN  JUL  AUG  SEP  OCT  NOV  1DEC 2DEC
0.0  0.0  0.0  14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8     11
0.0  0.0  0.0  14.5 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8     12
RETIREMENT PERCENTAGES
 11   12
0.0  0.0                    1978
0.0  0.0                    1985
0.0  0.0                    1990
0.0  0.0                    2000
0.0  0.0                    2010
0.0  0.0                    2020
0.0  0.0                    2030
0.0  0.0                    2040
0.1  0.0                    2050
CAPACITY INCREASE WITH DEPTH
  11      12
228.60 250.00
0                CAPACITY EXPANSION?
```

WELLAND DATA FILE

```
1,2                    GONOGO, DATA FILE IDENTIFIER
 7                     MAXIMUM VESSEL CLASS
0,1,0,0                SEASON EXTENSIONS
1,0,0                  LOCKING TIMES (NORMAL,LOW,HIGH)
0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70      SHIP UTILIZATION FACTORS
1.00,5.00,05.00,01.17,10.70,00.00,00.00,00.00      FACTOR,CALFAC,SYSFAC,SYSADD,SYSTEM
FLEET MIX SHIP BUILDING FACTORS
ORE   COAL  STONE GRAIN UBULK UCARGO    CLASS
0.00  0.00  0.00  0.00  0.20  0.20        4
0.20  0.10  0.20  0.05  0.30  0.00        5
0.00  0.10  0.10  0.35  0.30  0.80        6
0.80  0.80  0.70  0.60  0.20  0.00        7
CARRYING CAPACITY BY SHIP CLASS (IN SHORT TONS)
  4     5     6     7
09500. 21000. 15000. 27000.  IRON ORE _ STONE
08700. 14000. 15000. 21000.  COAL _ GRAIN
08700. 14000. 15000. 21000.  OTHER BULK _ GENERAL CARGO
VALIDATION TRANSIT DISTRIBUTION FACTORS
  JAN  FEB  MAY  APR  APR  MAY  JUN  JLY  AUG  SEP  OCT  NOV  DEC  DEC
 .000 .000 .000 .030 .050 .130 .120 .120 .120 .120 .120 .120 .050 .020
 .000 .000 .000 .040 .050 .130 .120 .120 .120 .120 .120 .120 .050 .010
 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000
CARGO PROJECTIONS  #### 1978 ####   (SHORT TONS / YEAR)
DOWNBOUND
16022.  2791.   2994.   6666.   1282.   110.    4919.   722.    5906.   1217.
1.      1638.   2755.   998.    116.
                #### 1978 ####
UPBOUND
0.      0.      6.      0.      0.      46.     11219.  0.      0.      613.
488.    427.    2335.   1195.   3598.
                #### 1985 ####
DOWNBOUND
20781.  2015.   4449.   7252.   1298.   112.    4855.   754.    5615.   1322.
1.      1825.   3234.   1088.   204.
                #### 1985 ####
UPBOUND
0.      0.      8.      0.      0.      49.     12000.  0.      0.      664.
600.    487.    2375.   1303.   8447.
                #### 1990 ####
DOWNBOUND
23346.  2136.   5666.   6237.   1311.   126.    5418.   901.    5155.   1400.
2.      1973.   3594.   1157.   188.
                #### 1990 ####
UPBOUND
0.      0.      20.     0.      0.      55.     13383.  0.      0.      701.
684.    531.    2415.   1386.   6864.
                #### 2000 ####
DOWNBOUND
24290.  2355.   6517.   5866.   1337.   139.    5497.   1052.   5714.   1541.
2.      2244.   4281.   1307.   223.
                #### 2000 ####
UPBOUND
0.      0.      23.     0.      0.      62.     15309.  0.      0.      768.
899.    620.    2469.   1569.   7142.
                #### 2010 ####
DOWNBOUND
26120.  2497.   7259.   6405.   1364.   157.    5895.   1250.   5718.   1694.
2.      2646.   4963.   1477.   287.
                #### 2010 ####
UPBOUND
0.      0.      25.     0.      0.      69.     17544.  0.      0.      842.
1048.   729.    2529.   1776.   8845.
                #### 2020 ####
DOWNBOUND
28024.  2547.   7934.   7062.   1391.   180.    6342.   1485.   5723.   1863.
2.      3188.   5739.   1668.   304.
                #### 2020 ####
UPBOUND
0.      0.      25.     0.      0.      80.     19911.  0.      0.      924.
1445.   861.    2454.   2011.   7058.
                #### 2030 ####
DOWNBOUND
30626.  2598.   8609.   7712.   1419.   206.    6846.   1764.   5729.   2050.
2.      3940.   6358.   1885.   439.
                #### 2030 ####
UPBOUND
0.      0.      25.     0.      0.      90.     22445.  0.      0.      1013.
1837.   1024.   2517.   2276.   11178.
                #### 2040 ####
DOWNBOUND
33228.  2651.   9286.   8341.   1448.   236.    7411.   2096.   5736.   2259.
2.      5018.   7678.   2130.   584.
                #### 2040 ####
UPBOUND
0.      0.      25.     0.      0.      103.    25125.  0.      0.      1113.
2338.   1224.   2596.   2576.   14645.
                #### 2050 ####
```

```
DOWNBOUND
35770.  2704.   10638.  9108.   1462.   271.    8045.   2490.   5744.   2492.
3.      6596.   8885.  2406.   760.
                ####  2050  ####
UPBOUND
0.      0.      25.    0.      0.      119.    28078.  0.      0.      1222.
2981.   1471.   2946.  2917.   18201.
HOURS AVAILABLE FOR LOCKING OPERATIONS BY MONTH
 JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEPT OCT  NOV  DEC  DEC
23.4 23.4 23.4 23.2 23.2 23.4 23.5 23.5 23.4 23.3 23.2 23.2 23.4 23.4
LOCKING TIME IN MINUTES BY SHIP CLASS
  4     5     6     7    SHIP CLASS
0035. 0035. 0045. 0047.  DOWN    CONSTRAINING LOCK
0039. 0039. 0047. 0048.  UP
0034. 0034. 0039. 0041.  DOWN   NON-CONSTRAINING LOCK
0034. 0034. 0040. 0041.  UP
LOW TIMES
  4     5     6     7    SHIP CLASS
0035. 0035. 0044. 0046.  DOWN     CONSTRAINING LOCK
0038. 0038. 0046. 0047.  UP
0034. 0034. 0038. 0040.  DOWN     NON-CONSTRAINING LOCK
0034. 0034. 0039. 0038.  UP
HIGH TIMES
  4     5     6     7    SHIP CLASS
0036. 0036. 0046. 0048.  DOWN     CONSTAINING LOCK
0039. 0039. 0048. 0049.  UP
0035. 0035. 0040. 0043.  DOWN     NON-CONSTRAINING LOCK
0035. 0035. 0041. 0041.  UP
LOCKING TIME STANDARD DEVIATION IN MINUTES BY SHIP CLASS
  4     5     6     7    SHIP CLASS
002.7 002.7 003.5 004.1  DOWN    CONSTRAINING LOCK
002.8 002.8 003.8 004.1  UP
002.7 002.7 002.8 003.0  DOWN   NON-CONSTRAINING LOCK
002.7 002.7 002.8 003.0  UP
VALIDATION BIAS TRAFFIC FACTORS
 E.AP  L.AP E.DC  L.DC
00.60 00.60 00.70 00.80
TURNBACK TIME IN MINUTES BY LOCK
CON.  NON-C
0000. 0000. 0000.
SHIP COST ($/HOUR) BY SHIP CLASS
   4       5       6       7       8       9       10      11     SHIP CLASS
000373. 000396. 000254. 000435. 000423. 000553. 000579. 000632.  OPERATING COST
000287. 000356. 000238. 000438. 000493. 000630. 000767. 000877.  CAPITAL COST
NON-COMMERCIAL CRAFT DAILY ARRIVAL - ICE LOCKAGES
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
00.0 00.0 00.0 00.0 00.0 00.0 00.5 01.0 01.0 00.5 00.0 00.0 00.0 00.0
02.0 03.0 03.0 01.0 00.0 00.0 00.5 01.0 01.0 00.5 00.0 00.0 00.0 00.5
LOADING FACTOR (FLOAD)
U   C   S   G    OB   GC
1.0 1.0 1.0 1.0 0.85 .85
ONE WAY DISTANCES(DISTN)
  ORE   COAL  STONE  GRAIN  U BULK G CARGO
01025. 00237. 00187. 01412. 00542. 01080.   DN
00588. 00589. 00589. 01043. 00589. 00684.   UP
LOADING RATE (FILL)
  ORE   COAL  STONE  GRAIN  U BULK G CARGO
02800. 09000. 02800. 01481. 00600. 00150.
02800. 09000. 02800. 01481. 00600. 00150.
02800. 09000. 02800. 01481. 00600. 00150.
02800. 09000. 02800. 01481. 00600. 00150.
UNLOADING RATE (EMPTY)
  ORE   COAL  STONE  GRAIN  U BULK G CARGO
02800. 01848. 00700. 01266. 00143. 00150.
02800. 01848. 00700. 01266. 00143. 00150.
02800. 01848. 00700. 01266. 00143. 00150.
11200. 06720. 11200. 01266. 00143. 00150.
HOURS PER MO. PER SEASON EXTENSION (HRS)
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   ORE EXT. 1
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   COAL
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   STONE
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   GRAIN
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   U BULK
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.   G CARGO
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.   EXT. 2
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
264. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.   EXT. 3
264. 000. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
```

```
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
264. 275. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.    EXT. 4
264. 275. 000. 189. 348. 725. 704. 728. 724. 698. 717. 694. 360. 134.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
000. 000. 000. 000. 348. 725. 704. 728. 724. 698. 717. 694. 360. 000.
VESSEL SPEED BY MONTH AND CLASS (VSA)
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
00.0 00.0 00.0 00.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.00    4    EXT. 1
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.70    5
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.40    6
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.00    7
00.0 00.0 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.00         EXT. 2
00.0 00.0 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.70
00.0 00.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.40
00.0 00.0 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.00
11.6 00.0 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.00         EXT. 3
12.7 00.0 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.70
13.9 00.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.40
13.1 00.0 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.00
11.6 08.7 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.00         EXT. 4
12.7 09.5 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.70
13.9 12.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.40
13.1 09.9 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.00
RELATIVE DEMAND INDEXES (DIN)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
00.0 00.0 00.0 00.0 07.1 10.0 10.0 10.0 10.0 10.0 10.0 10.0 06.0 00.0    EXT. 1
00.0 00.0 00.0 06.0 07.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0    EXT. 2
06.0 00.0 00.0 06.0 07.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0    EXT. 3
07.0 06.0 00.0 07.0 06.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0    EXT. 4
VESSEL RETIREMENT FRACTIONS (PD)
  4    5    6    7                          YEAR
0.00 0.00 0.00 0.00                         1978
0.56 0.30 0.20 0.00                         1985
1.00 0.50 0.30 0.00                         1990
1.00 0.80 0.50 0.10                         2000
1.00 0.85 0.80 0.20                         2010
1.00 0.95 0.85 0.30                         2020
1.00 1.00 0.95 0.80                         2030
1.00 1.00 1.00 0.85                         2040
1.00 1.00 1.00 0.90                         2050
BASE YEAR FLEET (BASEFT)
  4     5     6     7
6.10  1.60  0.00  8.20                      ORE
1.00  0.40  0.00  1.50                      COAL
2.00  2.00  0.00  0.20                      STONE
6.90  5.80 21.00 10.40                      GRAIN
0.40  1.10  6.40  0.60                      O BULK
3.20  0.50 10.10 0.00                       G CARGO
BIASED TRAFFIC FACTOR (BTF)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
0.00 0.00 0.00 0.00 0.60 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.75 0.00    EXT. 1
0.00 0.00 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.50    EXT. 2
0.50 0.00 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00    EXT. 3
0.00 0.50 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00    EXT. 4
EXTENDED SEASON DISTRIBUTION FRACTIONS
J=1    F=2    M=3    EAP=4  LDEC=5
0.0000 0.0000 0.0000 0.5000 0.5000
0.5000 0.0000 0.0000 0.2500 0.2500
0.3333 0.3333 0.0000 0.1667 0.1667
CAPACITY INCREASE WITH DEPTH (SHORT TONS PER INCH)
  4      5      6      7
0.00   91.80  61.80  113.10
1               CAPACITY EXPANSION? 1=YES,0=NO
1               CAPACITY EXPANSION MEASURE
0.075  0.075             LOCKING TIME          TRAVELING NEVELS
0.050  0.050             REDUCTION FACTORS     INCREASE SHIP SPEED
0.050  0.025                                   FASTER DUMP-FILL
0.030  0.030                                   TRAFFIC CONTROL
0.130  0.130                                   MAXIMUM UTILITY
5               LOCKING TIME REDUCTION SELECTOR
1               CAPACITY EXPANSION?
3               INCREASE ALLOWABLE DRAFT
52.0            NEW DRAFT
0               DEEPER DRAFT AND LARGER SHIPS
0               CAPACITY EXPANSION MEASURE 2
2               BUILD LARGER LOCKS
11              MAXIMUM SHIP CLASS
0.70 0.70 0.70 0.70 0.70      IBHF
```

FLEET MIX BUILDING FACTORS

ORE	COAL	STONE	GRAIN	OBULK	GCARGO	CLASS
0.00	0.00	0.25	0.00	0.20	0.10	4
0.00	0.00	0.05	0.00	0.30	0.10	5
0.10	0.05	0.10	0.15	0.30	0.40	6
0.10	0.35	0.60	0.05	0.20	0.05	7
0.00	0.10	0.00	0.00	0.00	0.30	8
0.00	0.00	0.00	0.00	0.00	0.05	9
0.60	0.40	0.00	0.60	0.00	0.00	10
0.20	0.10	0.00	0.20	0.00	0.00	11
0.00	0.00	0.00	0.00	0.00	0.00	12

SHIP CARRYING CAPACITIES

8	9	10	11	12	
28000.	45000.	60000.	72000.	90000.	ORE
24000.	28000.	60000.	72000.	90000.	COAL
28000.	45000.	60000.	72000.	90000.	STONE
24000.	28000.	60000.	72000.	90000.	GRAIN
24000.	28000.	60000.	72000.	90000.	O BULK
24000.	28000.	60000.	72000.	90000.	G CARGO

LOCKING TIMES (NORMAL)

4	5	6	7	8	9	10	11	12
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0

LOCKING TIMES (LOW)

4	5	6	7	8	9	10	11	12
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0

LOCKING TIME (HIGH)

4	5	6	7	8	9	10	11	12
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0
34.0	34.0	38.0	40.0	45.0	53.0	57.0	61.0	73.0

LOCKING TIME STANDARD DEVIATION

4	5	6	7	8	9	10	11	12
2.7	2.7	2.8	3.0	2.8	2.8	2.8	2.8	2.8
2.7	2.7	2.8	3.0	2.8	2.8	2.8	2.8	2.8
2.7	2.7	2.8	3.0	2.8	2.8	2.8	2.8	2.8
2.7	2.7	2.8	3.0	2.8	2.8	2.8	2.8	2.8

LOADING RATES

ORE	COAL	STONE	GRAIN	OBULK	GCARGO	CLASS
2800.	9000.	2800.	1481.	600.	150.	8
2800.	9000.	2800.	1481.	600.	150.	9
2800.	9000.	2800.	1481.	600.	150.	10
2800.	9000.	2800.	1481.	600.	150.	11
2800.	9000.	2800.	1481.	600.	150.	12

UNLOADING RATES

ORE	COAL	STONE	GRAIN	OBULK	GCARGO	CLASS
11200.	6720.	6720.	1266.	143.	150.	8
11200.	6720.	6720.	1266.	143.	150.	9
11200.	6720.	6720.	1266.	143.	150.	10
11200.	6720.	6720.	1266.	143.	150.	11
11200.	6720.	6720.	1266.	143.	150.	12

VESSEL SPEED

JAN	FEB	MAR	1APR	2APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	1DEC	2DEC
0.0	0.0	0.0	14.2	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.8
0.0	0.0	0.0	14.2	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.8
0.0	0.0	0.0	14.2	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.8
0.0	0.0	0.0	14.2	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.8
0.0	0.0	0.0	14.2	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.8

RETIREMENT PERCENTAGES

8	9	10	11	12	
0.0	0.0	0.0	0.0	0.0	1978
0.0	0.0	0.0	0.0	0.0	1985
0.0	0.0	0.0	0.0	0.0	1990
0.2	0.0	0.0	0.0	0.0	2000
0.3	0.0	0.0	0.0	0.0	2010
0.8	0.0	0.2	0.0	0.0	2020
0.92	0.0	0.3	0.0	0.0	2030
1.0	1.0	0.5	0.0	0.0	2040
1.0	1.0	0.6	0.1	0.0	2050

CAPACITY INCREASE WITH DEPTH

8	9	10	11	12
115.60	167.10	207.10	228.60	250.00

0 CAPACITY EXPANSION?

ST. LAWRENCE RIVER DATA FILE

```
1,3                    GONOGO, DATA FILE IDENTIFIER
 7                     MAXIMUM VESSEL CLASS
0,1,0,0                SEASON EXTENSIONS
1,0,0                  LOCKING TIMES (NORMAL,LOW,HIGH)
0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70,0.70        SHIP UTILIZATION FACTORS
1.00,5.00,05.00,00.00,36.00,00.33,00.00,00.00     FACTOR,CALFAC,SYSFAC,SYSADD,SYSTEM
FLEET MIX SHIP BULDING FACTORS
ORE   COAL  STONE GRAIN OBULK GCARGO    CLASS
0.00  0.00  0.00  0.00  0.20  0.20        4
0.20  0.10  0.20  0.05  0.30  0.00        5
0.00  0.10  0.10  0.35  0.30  0.80        6
0.80  0.80  0.70  0.60  0.20  0.00        7
CARRYING CAPACITY BY SHIP CLASS (IN SHORT TONS)
  4      5      6      7
09500. 21000. 15000. 27000.  IRON ORE _ STONE
08700. 14000. 15000. 21000.  COAL _ GRAIN
08700. 14000. 15000. 21000.  BULK _ GENERAL CARGO
TRANSIT DISTRIBUTION FACTOR FOR VALIDATION
  JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
 .000 .000 .000 .020 .040 .130 .124 .124 .124 .124 .124 .130 .040 .020
 .000 .000 .000 .030 .045 .125 .120 .120 .120 .120 .120 .125 .040 .035
 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000 .000
CARGO PROJECTIONS  #### 1978 ####  (SHORT TONS / YEAR)
DOWNBOUND
15549.  2365.   2883.   6666.   1282.   110.    0.      809.    1.      889.
1.      1127.   2675.   1118.   194.
                #### 1978 ####
UPBOUND
0.      0.      6.      0.      0.      46.     16592.  17.     1003.   1985.
107.    827.    2366.   1868.   3723.
                #### 1985 ####
DOWNBOUND
20034.  1704.   4283.   7252.   1298.   112.    0.      861.    1.      965.
1.      1267.   3131.   1220.   306.
                #### 1985 ####
UPBOUND
0.      0.      8.      0.      0.      49.     16015.  16.     1095.   2100.
132.    922.    2406.   2038.   8610.
                #### 1990 ####
DOWNBOUND
22478.  1807.   5463.   6237.   1311.   126.    0.      1050.   1.      1021.
1.      1378.   3489.   1297.   314.
                #### 1990 ####
UPBOUND
0.      0.      20.     0.      0.      55.     19873.  18.     1161.   2181.
151.    996.    2441.   2165.   7066.
                #### 2000 ####
DOWNBOUND
23337.  1991.   6284.   5866.   1337.   139.    0.      1234.   1.      1124.
2.      1626.   4140.   1460.   403.
                #### 2000 ####
UPBOUND
0.      0.      23.     0.      0.      62.     20263.  18.     1279.   2334.
200.    1150.   2498.   2430.   7432.
                #### 2010 ####
DOWNBOUND
25081.  2112.   7048.   6405.   1364.   157.    0.      1466.   2.      1235.
2.      1957.   4831.   1645.   529.
                #### 2010 ####
UPBOUND
0.      0.      25.     0.      0.      69.     22495.  19.     1411.   2500.
256.    1321.   2559.   2727.   9237.
                #### 2020 ####
DOWNBOUND
26898.  2154.   7647.   7062.   1391.   180.    0.      1742.   3.      1358.
2.      2418.   5565.   1852.   628.
                #### 2020 ####
UPBOUND
0.      0.      25.     0.      0.      80.     24860.  19.     1556.   2679.
327.    1524.   2635.   3060.   7588.
                #### 2030 ####
DOWNBOUND
29381.  2198.   8296.   7712.   1419.   206.    0.      2071.   2.      1494.
2.      3079.   6449.   2086.   875.
                #### 2030 ####
UPBOUND
0.      0.      25.     0.      0.      90.     27389.  20.     1715.   2875.
418.    1768.   2728.   3435.   11890.
                #### 2040 ####
DOWNBOUND
31864.  2242.   8946.   8341.   1448.   236.    0.      2460.   3.      1646.
2.      4051.   7474.   2350.   1171.
                #### 2040 ####
UPBOUND
0.      0.      25.     0.      0.      103.    30067.  20.     1890.   3087.
534.    2061.   2842.   3857.   15603.
                #### 2050 ####
```

```
DOWNBOUND
34289.   2287.    10244.   9108.    1462.    270.     0.       2923.    4.       1817.
5.       5508.    8665.    2648.    1551.
                  **** 2050 ****
UPBOUND
0.       0.       25.      0.       0.       119.     33016.   21.      2084.    3319.
6482.    2416.    2982.    4431.    19491.
HOURS AVAILABLE FOR LOCKING OPERATIONS BY MONTH
 JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG SEPT  OCT  NOV  DEC  DEC
23.2 23.0 23.7 23.2 23.2 23.2 23.3 23.3 23.2 23.2 23.2 22.9 23.2 23.2
LOCKING TIME IN MINUTES BY SHIP CLASS
  4     5     6     7    SHIP CLASS
0034. 0034. 0039. 0041.  DOWN     FOR CONSTRAINING LOCK
0034. 0034. 0040. 0041.  UP
0031. 0031. 0036. 0037.  DOWN     FOR NON-CONSTRAINING LOCK
0031. 0031. 0036. 0037.  UP
LOW TIMES
  4     5     6     7    SHIP CLASS
0034. 0034. 0038. 0040.  DOWN     FOR CONSTRAINING LOCK
0033. 0033. 0039. 0040.  UP
0031. 0031. 0035. 0036.  DOWN     FOR NON-CONSTRAINING LOCK
0031. 0031. 0035. 0036.  UP
HIGH TIMES
  4     5     6     7    SHIP CLASS
0035. 0035. 0040. 0042.  DOWN     FOR CONSTRAINING LOCK
0035. 0035. 0041. 0041.  UP
0032. 0032. 0037. 0039.  DOWN     FOR NON-CONSTRAINING LOCK
0032. 0032. 0037. 0037.  UP
LOCKING TIME STANDARD DEVIATION IN MINUTES BY SHIP CLASS
  4     5     6     7    SHIP CLASS
002.7 002.7 002.8 003.0  DOWN     FOR CONSTRAINING LOCK
002.7 002.7 002.8 003.0  UP
002.3 002.3 002.7 002.8  DOWN     FOR NON-CONSTRAINING LOCK
002.3 002.3 002.7 002.8  UP
VALIDATION BIAS TRAFFIC FACTORS
 E.AP  L.AP  E.DC  L.DC
01.00 00.80 00.20 00.80
TURNBACK TIME IN MINUTES BY LOCK
CON.  NON-C.
0000. 0000. 0000.
SHIP COST ($/HOUR) BY SHIP CLASS
  4       5       6       7       8       9       10      11     SHIP CLASS
000373. 000396. 000254. 000435. 000423. 000553. 000579. 000632.  OPERATING COST
000287. 000356. 000238. 000438. 000493. 000630. 000767. 000877.  CAPITAL COST
NON-COMMERCIAL CRAFT DAILY ARRIVAL - ICE LOCKAGES
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
00.0 00.0 00.0 00.0 00.0 00.0 01.0 01.5 01.5 01.0 00.0 00.0 00.0 00.0   UP
02.0 03.0 03.0 01.0 00.0 00.0 01.0 01.5 01.5 01.0 00.0 00.0 00.0 00.0   DN
LOADING FACTOR - FLOAD
O   C   S   G    OB  GC
1.001.001.001.000.850.85
ONE WAY DISTANCES(DISTN)
  ORE  COAL  STONE  GRAIN  O BULK G CARGO
01025. 00237. 00187. 01412. 00542. 01080.   DN
00588. 00589. 00589. 01043. 00589. 00684.   UP
LOADING RATE (FILL)
  ORE  COAL  STONE  GRAIN  O BULK G CARGO
02800. 09000. 02800. 01481. 00600. 00150.   4
02800. 09000. 02800. 01481. 00600. 00150.   5
02800. 09000. 02800. 01481. 00600. 00150.   6
02800. 09000. 02800. 01481. 00600. 00150.   7
UNLOADING RATE (EMPTY)
  ORE  COAL  STONE  GRAIN  O BULK G CARGO
02800. 01848. 00700. 01266. 00143. 00150.   4
02800. 01848. 00700. 01266. 00143. 00150.   5
02800. 01848. 00700. 01266. 00143. 00150.   6
11200. 06720. 11200. 01266. 00143. 00150.   7
HOURS PER MO. PER SEASON EXTENSION (HRS)
JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   ORE EXT. 1
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   COAL
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   STONE
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   GRAIN
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   O BULK
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   G CARGO
000. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   ORE EXT. 2
000. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   COAL
000. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   STONE
000. 000. 000. 188. 3474 718. 698. 722. 718. 690. 714. 688. 359. 131.   GRAIN
000. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   O BULK
000. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   G CARGO
256. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   ORE  EXT. 3
256. 000. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.   COAL
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   STONE
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.   GRAIN
```

```
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    0 BULK
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    G CARGO
256. 267. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.    ORE  EXT. 4
256. 267. 000. 188. 347. 718. 698. 722. 718. 690. 714. 688. 359. 131.    COAL
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    STONE
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    GRAIN
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    O BULK
000. 000. 000. 000. 347. 718. 698. 722. 718. 690. 714. 688. 359. 000.    G CARGO
VESSEL SPEED BY MONTH AND CLASS (VSA)
 JAN  FEB  MAR  APR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  DEC
00.0 00.0 00.0 00.0 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.0    4   EXT. 1
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.7    5
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.4    6
00.0 00.0 00.0 00.0 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.0    7
00.0 00.0 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.0    4   EXT. 2
00.0 00.0 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.7    5
00.0 00.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.4    6
00.0 00.0 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.0    7
11.6 00.0 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.0    4   EXT. 3
12.7 00.0 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.7    5
13.9 00.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.4    6
13.1 00.0 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.0    7
11.6 08.7 00.0 10.7 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.9 13.0    4   EXT. 4
12.7 09.5 00.0 11.8 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 13.7    5
13.9 12.0 00.0 13.4 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.4    6
13.1 09.9 00.0 12.2 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.7 14.0    7
RELATIVE DEMAND INDEXES (DIN)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
00.0 00.0 00.0 00.0 06.3 10.0 10.0 10.0 10.0 10.0 10.0 10.0 06.3 00.0   EXT. 1
00.0 00.0 00.0 06.0 07.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT. 2
06.0 00.0 00.0 06.0 07.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT. 3
07.0 06.0 00.0 06.0 07.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 08.0 07.0   EXT. 4
VESSEL RETIREMENT FRACTIONS (PO)
   4    5    6    7              YEAR
0.00 0.00 0.00 0.00              1978
0.56 0.30 0.20 0.00              1985
1.00 0.50 0.30 0.00              1990
1.00 0.80 0.50 0.00              2000
1.00 0.85 0.80 0.20              2010
1.00 0.95 0.85 0.30              2020
1.00 1.00 0.95 0.80              2030
1.00 1.00 1.00 0.85              2040
1.00 1.00 1.00 0.90              2050
BASE YEAR FLEET (BASEFT)
   4     5     6     7
0.00  5.70  0.00  6.40          ORE
0.90  0.30  0.00  0.50          COAL
0.30  0.70  0.40  0.10          STONE
11.20 4.70  22.10 7.90          GRAIN
2.80  0.40  7.40  0.00          O BULK
4.20  0.70  11.40 0.00          G CARGO
BIASED TRAFFIC FACTOR (BTF)
 JAN  FEB  MAR E.AP L.AP  MAY  JUN  JLY  AUG  SEP  OCT  NOV E.DC L.DC
0.00 0.00 0.00 0.00 0.90 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.50 0.00   EXT. 1
0.00 0.00 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00   EXT. 2
0.50 0.00 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00   EXT. 3
0.00 0.50 0.00 0.50 0.10 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00   EXT. 4
EXTENDED SEASON DISTRIBUTION FRACTIONS
J=1    F=2    M=3    EAPR=4 LDEC=5
0.0000 0.0000 0.0000 0.5000 0.5000       ISN1
0.5000 0.0000 0.0000 0.2500 0.2500       ISN3
0.3333 0.3333 0.0000 0.1667 0.1667       ISN4
CAPCITY INCREASE WITH DEPTH (SHORT TONS PER INCH)
   4     5     6     7
0.00   91.80  61.80  113.10
1                CAPACITY EXPANSION? 1=YES,0=NO
1                CAPACITY EXPANSION MEASURE
0.075  0.075                LOCKING TIME          TRAVELING NEVELS
0.025  0.025                REDUCTION FACTORS     INCREASE SHIP SPEED
0.055  0.010                                      FASTER DUMP-FILL
0.045  0.045                                      TRAFFIC CONTROL
0.130  0.130                                      MAXIMUM UTILITY
5                LOCKING TIME REDUCTION SELECTOR
1                CAPACITY EXPANSION?
3                INCREASE ALLOWABLE DRAFT
52.0             NEW DRAFT
0                DEEPER DRAFT AND LARGER SHIPS
0                CAPACITY EXPANSION MEASURE 2
2                BUILD LARGER LOCKS
11               MAXIMUM SHIP CLASS
0.70 0.70 0.70 0.70 0.70      ZBHF
```

```
 FLEET MIX BUILDING FACTORS
 ORE    COAL  STONE GRAIN OBULK GCARGO          CLASS
0.00  0.00  0.25  0.00  0.20  0.10                4
0.00  0.00  0.05  0.00  0.30  0.10                5
0.10  0.05  0.10  0.15  0.30  0.40                6
0.10  0.35  0.60  0.05  0.20  0.05                7
0.00  0.10  0.00  0.00  0.00  0.30                8
0.00  0.00  0.00  0.00  0.00  0.05                9
0.60  0.40  0.00  0.60  0.00  0.00               10
0.20  0.10  0.00  0.20  0.00  0.00               11
0.00  0.00  0.00  0.00  0.00  0.00               12
SHIP CARRYING CAPACITIES
   8      9      10     11     12
28000. 45000. 60000. 72000. 90000.            ORE
24000. 28000. 60000. 72000. 90000.            COAL
28000. 45000. 60000. 72000. 90000.            STONE
24000. 28000. 60000. 72000. 90000.            GRAIN
24000. 28000. 60000. 72000. 90000.            O BULK
24000. 28000. 60000. 72000. 90000.            G CARGO
LOCKING TIMES (NORMAL)
  4     5     6     7     8     9     10    11    12
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
LOCKING TIMES (LOW)
  4     5     6     7     8     9     10    11    12
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
LOCKING TIME (HIGH)
  4     5     6     7     8     9     10    11    12
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
34.0  34.0  38.0  40.0  45.0  53.0  57.0  61.0  73.0
LOCKING TIME STANDARD DEVIATION
  4     5     6     7     8     9     10    11    12
2.7   2.7   2.8   3.0   2.8   2.8   2.8   2.8   2.8
2.7   2.7   2.8   3.0   2.8   2.8   2.8   2.8   2.8
2.7   2.7   2.8   3.0   2.8   2.8   2.8   2.8   2.8
2.7   2.7   2.8   3.0   2.8   2.8   2.8   2.8   2.8
LOADING RATES
 ORE    COAL   STONE  GRAIN  OBULK  GCARGO            CLASS
2800.  9000.  2800.  1481.  600.   150.                 8
2800.  9000.  2800.  1481.  600.   150.                 9
2800.  9000.  2800.  1481.  600.   150.                10
2800   9000.  2800.  1481.  600.   150.                11
2800.  9000.  2800.  1481.  600.   150.                12
UNLOADING RATES
 ORE    COAL   STONE  GRAIN  OBULK  GCARGO            CLASS
11200. 6720.  6720.  1266.  143.   150.                 8
11200. 6720.  6720.  1266.  143.   150.                 9
11200. 6720.  6720.  1266.  143.   150.                10
11200. 6720.  6720.  1266.  143.   150.                11
11200. 6720.  6720.  1266.  143.   150.                12
VESSEL SPEED
JAN  FEB  MAR  1APR 2APR MAY  JUN  JUL  AUG  SEP  OCT  NOV  1DEC 2DEC
0.0  0.0  0.0  14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
0.0  0.0  0.0  14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
0.0  0.0  0.0  14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
0.0  0.0  0.0  14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
0.0  0.0  0.0  14.2 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.8
RETIREMENT PERCENTAGES
 8    9    10   11   12
0.0  0.0  0.0  0.0  0.0      1978
0.0  0.0  0.0  0.0  0.0      1985
0.0  0.0  0.0  0.0  0.0      1990
0.2  0.0  0.0  0.0  0.0      2000
0.3  0.0  0.0  0.0  0.0      2010
0.8  0.0  0.2  0.0  0.0      2020
0.92 0.0  0.3  0.0  0.0      2030
1.0  1.0  0.5  0.0  0.0      2040
1.0  1.0  0.6  0.1  0.0      2050
CAPACITY INCREASE WITH DEPTH
  8      9      10     11     12
115.60 167.10 207.10 228.60 250.00
0               CAPACITY EXPANSION?
```

APPENDIX D

SAMPLE OUTPUT LISTING

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

PROJECTED CARGO TONNAGE
(THOUSAND SHORT TONS)

	1 APRIL			2 APRIL			MAY			JUNE			JULY		
	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL
WHEAT	0	253	253	0	622	622	0	3058	3058	0	2970	2970	0	3083	3083
SOY BEANS	0	1	1	0	2	2	0	8	8	0	8	8	0	8	8
BARLEY+RYE	0	56	56	0	138	138	0	678	678	0	659	659	0	684	684
CORN	0	16	16	0	38	38	0	188	188	0	182	182	0	189	189
OIL SEED	0	14	14	0	35	35	0	173	173	0	168	168	0	175	175
LIMESTONE	23	0	23	56	0	56	275	0	275	267	0	267	277	0	277
IRON ORE	2	813	816	5	1981	1987	26	9740	9766	26	9462	9487	26	9820	9846
COAL	73	52	125	178	127	305	874	625	1499	849	607	1456	881	630	1511
RAW MATL	1	1	1	1	2	4	6	11	17	6	10	17	6	11	17
PETROLEUM	13	2	14	31	4	35	153	20	173	149	20	169	155	20	175
CEMENT	10	0	10	26	0	26	126	0	127	123	0	123	128	0	128
MINERALS	6	1	6	14	1	15	67	7	74	65	6	72	68	7	74
DRY BULK	1	21	22	3	52	54	13	254	267	13	246	259	14	256	269
GEN CARGO	8	7	15	20	17	37	99	83	182	96	81	177	100	84	184
STEEL PROD	1	3	4	2	8	10	12	38	50	12	37	49	12	38	50
TOTALS	138	1240	1376	336	3027	3364	1651	14883	16535	1606	14456	16063	1667	15005	16670

	AUGUST			SEPTEM			OCTOBER			NOVEMBER			1 DECEM		
	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL
WHEAT	0	3095	3095	0	2970	2970	0	3070	3070	0	2983	2983	0	479	479
SOY BEANS	0	8	8	0	8	8	0	8	8	0	8	8	0	1	1
BARLEY+RYE	0	687	687	0	659	659	0	681	681	0	662	662	0	106	106
CORN	0	190	190	0	182	182	0	189	189	0	183	183	0	29	29
OIL SEED	0	175	175	0	168	168	0	174	174	0	169	169	0	27	27
LIMESTONE	278	0	278	267	0	267	276	0	276	268	0	268	43	0	43
IRON ORE	27	9859	9886	26	9462	9487	26	9780	9806	26	9502	9527	4	1527	1531
COAL	885	633	1517	849	607	1456	878	628	1505	853	610	1462	137	98	235
RAW MATL	6	11	17	6	10	17	6	11	17	6	11	17	1	2	3
PETROLEUM	155	20	176	149	20	169	154	20	174	150	20	169	24	3	27
CEMENT	128	0	128	123	0	123	127	0	127	123	0	124	20	0	20
MINERALS	68	7	75	65	6	72	68	7	74	66	6	72	11	1	12
DRY BULK	14	257	270	13	246	259	14	255	268	13	247	260	2	40	42
GEN CARGO	100	84	184	96	81	177	99	83	183	97	81	178	16	13	29
STEEL PROD	12	38	51	12	37	49	12	38	50	12	37	49	2	6	8
TOTALS	1673	15064	16737	1606	14456	16063	1660	14944	16602	1614	14519	16131	260	2332	2592

	2 DECEM			JANUARY			FEBRUARY			MARCH			YEAR		
	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL	UP	DOWN	TOTAL
WHEAT	0	333	333	0	0	0	0	0	0	0	0	0	0	22916	22916
SOY BEANS	0	1	1	0	0	0	0	0	0	0	0	0	0	61	61
BARLEY+RYE	0	74	74	0	0	0	0	0	0	0	0	0	0	5084	5084
CORN	0	20	20	0	0	0	0	0	0	0	0	0	0	1406	1406
OIL SEED	0	19	19	0	0	0	0	0	0	0	0	0	0	1297	1297
LIMESTONE	30	0	30	0	0	0	0	0	0	0	0	0	2060	0	2060
IRON ORE	3	1061	1064	0	0	0	0	0	0	0	0	0	197	73007	73203
COAL	95	68	163	0	0	0	0	0	0	0	0	0	6552	4685	11234
RAW MATL	1	1	2	0	0	0	0	0	0	0	0	0	46	81	129
PETROLEUM	17	2	19	0	0	0	0	0	0	0	0	0	1150	151	1300
CEMENT	14	0	14	0	0	0	0	0	0	0	0	0	948	0	950
MINERALS	7	1	8	0	0	0	0	0	0	0	0	0	505	50	554
DRY BULK	1	28	29	0	0	0	0	0	0	0	0	0	101	1902	1999
GEN CARGO	11	9	20	0	0	0	0	0	0	0	0	0	742	623	1366
STEEL PROD	1	4	5	0	0	0	0	0	0	0	0	0	90	284	375
TOTALS	180	1621	1801	0	0	0	0	0	0	0	0	0	12391	111547	123934

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

FLEET MIX

CLASS	ORE		COAL		STONE		GRAIN		O BULK		GCARGO		TOTAL
	NUMBER SHIPS	BUILD %	NUMBER SHIPS	BUILD %	NUMBER SHIPS	BUILD %	NUMBER SHIPS	BUILD %	NUMBER SHIPS	BUILD %	NUMBER SHIPS	BUILD %	
4	0.0	0	.4	0	.2	0	.4	0	2.5	30	1.1	20	4.6
5	19.6	10	4.2	10	.8	40	7.7	10	7.1	60	0.0	0	39.4
6	0.0	0	.8	5	0.0	0	11.1	20	0.0	0	4.4	80	16.3
7	7.8	20	1.1	40	.4	60	36.2	70	4.8	10	0.0	0	50.3
8	6.8	10	.3	15	0.0	0	0.0	0	0.0	0	0.0	0	7.1
9	1.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	1.0
10	9.4	60	1.5	30	0.0	0	0.0	0	0.0	0	0.0	0	10.9
TOTALS	44.6		8.3		1.4		55.4		14.4		5.5		129.6
COMPOSITE SHIP CLASS	7.0		6.3		5.4		6.5		5.5		5.6		6.5

VESSEL CHARACTERISTICS

VESSEL CLASS	VESSEL LENGTH RANGE (FT) MIN	MAX	MEAN VESSEL SPEED (MPH)	MAXIMUM CARRYING CAPACITY (S.TONS)	VESSEL UTILIZATION (%)	LOCKING TIME (MIN) UP	DN	CAPACITY INCREASE WITH DRAFT (ST/IN)
3	(PLEASURE CRAFT, NON-COMMERCIAL VESSELS, AND ICE LOCKAGES)							
4	0	599	13.8	9500	80	68	73	0.0
5	600	699	13.9	21000	80	65	75	91.8
6	400	699	14.7	15000	80	65	74	61.8
7	700	749	14.7	27000	80	61	77	113.1
8	750	849	14.9	28000	80	68	78	115.6
9	850	989	14.9	45000	80	73	101	167.1
10	990	1099	14.9	60000	80	89	106	207.1

CLASS 5 IS LAKERS OF CLASSES 5 AND 6
CLASS 6 IS OCEAN GOING VESSELS

1

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

YEARLY TRANSITS BY COMMODITY AND CLASS

LOADED TRANSITS

	ORE		COAL		STONE		GRAIN		OTHER BULK		GEN CARGO	
CLASS	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
4	0	0	22	14	14	0	0	14	58	45	22	23
5	0	1035	144	102	53	0	0	252	106	83	0	0
6	0	0	30	22	0	0	0	352	0	0	53	58
7	0	423	35	23	30	0	0	1051	61	46	0	0
8	0	361	7	7	0	0	0	0	0	0	0	0
9	0	50	0	0	0	0	0	0	0	0	0	0
10	0	461	50	48	0	0	0	0	0	0	0	0
TOTAL	0	2330	288	206	97	0	0	1649	225	174	75	81

	LOADED TRANSITS			BALLASTED TRANSITS			TOTAL ALL		
	TOTAL			TOTAL					
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
4	114	96	212	20	36	56	136	132	268
5	303	1452	1755	1198	61	1259	1501	1513	3014
6	83	432	515	359	16	375	442	448	890
7	126	1543	1669	1426	25	1451	1552	1568	3120
8	7	368	375	354	2	356	361	370	731
9	0	50	50	48	0	48	48	50	98
10	50	499	549	448	10	458	498	509	1007
TOTAL	685	4440	5125	3853	150	4003	4538	4590	9128

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1 LOCKING TIME NORM

DAILY TRANSIT DEMAND BY MONTH AND CLASS

1 APRIL

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0
4	.1	0.0	.1	.1	0.0	.1	.2	0.0	.2
5	.2	1.3	1.5	1.1	0.0	1.1	1.3	1.3	2.6
6	.1	.4	.5	.3	0.0	.3	.4	.4	.8
7	.1	1.6	1.7	1.1	0.0	1.1	1.2	1.6	2.8
8	0.0	.4	.4	.3	0.0	.3	.3	.4	.7
9	0.0	.1	.1	0.0	0.0	0.0	0.0	.1	.1
10	0.0	.5	.5	.4	0.0	.4	.4	.5	.9
TOTAL	.5	4.3	4.8	3.3	1.0	4.3	3.8	5.3	9.1

2 APRIL

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.2	0.0	.2	.2	.1	.3	.4	.1	.5
5	.6	2.6	3.2	2.6	.1	2.7	3.2	2.7	5.9
6	.1	.8	.9	.8	0.0	.8	.9	.8	1.7
7	.2	3.1	3.3	2.8	0.0	2.8	3.0	3.1	6.1
8	0.0	.8	.8	.7	0.0	.7	.7	.8	1.5
9	0.0	.1	.1	.1	0.0	.1	.1	.1	.2
10	.1	1.0	1.1	.9	0.0	.9	1.0	1.0	2.0
TOTAL	1.2	8.4	9.6	8.1	.2	8.3	9.3	8.6	17.9

MAY

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.2	6.5	6.3	.3	6.6	7.6	5.5	13.1
6	.3	1.6	1.9	1.8	.1	1.9	2.1	1.7	3.8
7	.5	6.2	6.7	6.7	.1	6.8	7.2	6.3	13.5
8	0.0	1.5	1.5	1.6	0.0	1.6	1.6	1.5	3.1
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.8	16.8	19.6	19.1	.7	19.8	21.9	17.5	39.4

JUNE

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.2	6.5	6.3	.3	6.6	7.6	5.5	13.1
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.2	6.7	6.7	.1	6.8	7.2	6.3	13.5
8	0.0	1.5	1.5	1.6	0.0	1.6	1.6	1.5	3.1
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.9	16.8	19.7	19.2	.7	19.9	22.1	17.5	39.6

JULY

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.3	6.6	6.3	.3	6.6	7.6	5.6	13.2
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.3	6.8	6.7	.1	6.8	7.2	6.4	13.6
8	0.0	1.6	1.6	1.6	0.0	1.6	1.6	1.6	3.2
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.9	17.1	20.0	19.2	.7	19.9	22.1	17.8	39.9

AUGUST

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.3	6.6	6.3	.3	6.6	7.6	5.6	13.2
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.3	6.8	6.7	.1	6.8	7.2	6.4	13.6
8	0.0	1.6	1.6	1.6	0.0	1.6	1.6	1.6	3.2
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.2	0.0	2.2	2.4	2.0	4.4
TOTAL	2.9	17.1	20.0	19.3	.7	20.0	22.2	17.8	40.0

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

DAILY TRANSIT DEMAND BY MONTH AND CLASS
CONTINUED

SEPTEM

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.2	6.5	6.3	.3	6.6	7.6	5.5	13.1
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.2	6.7	6.7	.1	6.8	7.2	6.3	13.5
8	0.0	1.5	1.5	1.6	0.0	1.6	1.6	1.5	3.1
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.9	16.8	19.7	19.2	.7	19.9	22.1	17.5	39.6

OCTOBER

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.2	6.5	6.3	.3	6.6	7.6	5.5	13.1
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.2	6.7	6.7	.1	6.8	7.2	6.3	13.5
8	0.0	1.5	1.5	1.6	0.0	1.6	1.6	1.5	3.1
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.9	16.8	19.7	19.2	.7	19.9	22.1	17.5	39.6

NOVEMBER

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.5	.1	.6	.4	.2	.6	.9	.3	1.2
5	1.3	5.3	6.6	6.3	.3	6.6	7.6	5.6	13.2
6	.4	1.6	2.0	1.9	.1	2.0	2.3	1.7	4.0
7	.5	6.3	6.8	6.7	.1	6.8	7.2	6.4	13.6
8	0.0	1.6	1.6	1.6	0.0	1.6	1.6	1.6	3.2
9	0.0	.2	.2	.2	0.0	.2	.2	.2	.4
10	.2	2.0	2.2	2.1	0.0	2.1	2.3	2.0	4.3
TOTAL	2.9	17.1	20.0	19.2	.7	19.9	22.1	17.8	39.9

1 DECEM

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.2	0.0	.2	.1	0.0	.1	.3	0.0	.3
5	.4	.7	1.1	2.0	.1	2.1	2.4	.8	3.2
6	.1	.2	.3	.6	0.0	.6	.7	.2	.9
7	.2	.8	1.0	2.2	0.0	2.2	2.4	.8	3.2
8	0.0	.2	.2	.5	0.0	.5	.5	.2	.7
9	0.0	0.0	0.0	.1	0.0	.1	.1	0.0	.1
10	.1	.3	.4	.7	0.0	.7	.8	.3	1.1
TOTAL	1.0	2.2	3.2	6.2	.1	6.3	7.2	2.3	9.5

2 DECEM

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	.1	0.0	.1	.1	0.0	.1	.2	0.0	.2
5	.3	.2	.5	1.4	.1	1.5	1.7	.3	2.0
6	.1	.1	.2	.4	0.0	.4	.5	.1	.6
7	.1	.3	.4	1.5	0.0	1.5	1.6	.3	1.9
8	0.0	.1	.1	.4	0.0	.4	.4	.1	.5
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	.1	.1	.5	0.0	.5	.5	.1	.6
TOTAL	.6	.8	1.4	4.3	.1	4.4	4.9	.9	5.8

JANUARY

CLASS	UP LOAD	UP BLST	UP TOTAL	DN LOAD	DN BLST	DN TOTAL	TOTAL LOAD	TOTAL BLST	TOTAL TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

DAILY TRANSIT DEMAND BY MONTH AND CLASS
CONTINUED

	FEBRUARY									MARCH								
	UP			DN			TOTAL			UP			DN			TOTAL		
CLASS	LOAD	BLST	TOTAL	LOAD	BLST	TOTAL	LOAD	BLST	TOTAL	LOAD	BLST	TOTAL	LOAD	BLST	TOTAL	LOAD	BLST	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**** GL/SLS LOCK CAPACITY MODEL ****
**** SOO LOCK SYSTEM ****
**** 1985 ****
**** SEASON EXTENSION 1! LOCKING TIME NORM ****

**** ACTUAL TRANSITS ****

1 APRIL

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.1	.1	.2	0.0	0.0	0.0	0.0	0.0	0.0	.3	.2	.5
5	.2	.7	.9	0.0	.3	.3	1.3	0.0	1.3	.6	1.8	2.4	0.0	.8	.8	2.6	.1	2.7
6	.1	.2	.3	0.0	.1	.1	.4	0.0	.4	.1	.5	.6	0.0	.2	.2	.8	0.0	.8
7	.1	.8	.9	0.0	.4	.4	1.6	0.0	1.6	.2	1.9	2.1	0.0	.9	.9	3.1	0.0	3.1
8	0.0	0.0	0.0	0.0	.3	.3	.4	0.0	.4	0.0	0.0	0.0	0.0	.7	.7	.8	0.0	.8
9	0.0	0.0	0.0	.1	0.0	.1	0.0	0.0	0.0	0.0	0.0	0.0	.1	.1	.2	0.0	0.0	0.0
10	0.0	0.0	0.0	.6	.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	.9	2.0	0.0	0.0	0.0
TOTAL	.4	1.7	2.1	.7	1.5	2.2	3.8	.1	3.9	.9	4.2	5.1	1.2	3.6	4.8	7.6	.3	7.9

2 APRIL

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.3	.2	.5	0.0	0.0	0.0	0.0	0.0	0.0	.3	.2	.5
5	.6	1.8	2.4	0.0	.8	.8	2.6	.1	2.7	.6	1.8	2.4	0.0	.8	.8	2.6	.1	2.7
6	.1	.5	.6	0.0	.2	.2	.8	0.0	.8	.1	.5	.6	0.0	.2	.2	.8	0.0	.8
7	.2	1.9	2.1	0.0	.9	.9	3.1	0.0	3.1	.2	1.9	2.1	0.0	.9	.9	3.1	0.0	3.1
8	0.0	0.0	0.0	0.0	.7	.7	.8	0.0	.8	0.0	0.0	0.0	0.0	.7	.7	.8	0.0	.8
9	0.0	0.0	0.0	.1	.1	.2	0.0	0.0	0.0	0.0	0.0	0.0	.1	.1	.2	0.0	0.0	0.0
10	0.0	0.0	0.0	1.1	.9	2.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	.9	2.0	0.0	0.0	0.0
TOTAL	.9	4.2	5.1	1.2	3.6	4.8	7.6	.3	7.9	.9	4.2	5.1	1.2	3.6	4.8	7.6	.3	7.9

MAY

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.3	5.6	0.0	1.9	1.9	5.2	.3	5.5	1.3	4.4	5.7	0.0	1.9	1.9	5.2	.3	5.5
6	.3	1.3	1.6	0.0	.6	.6	1.6	.1	1.7	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.6	5.1	0.0	2.0	2.0	6.2	.1	6.3	.5	4.6	5.1	0.0	2.1	2.1	6.2	.1	6.3
8	0.0	0.0	0.0	0.0	1.6	1.6	1.5	0.0	1.5	0.0	0.0	0.0	0.0	1.6	1.6	1.5	0.0	1.5
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0
TOTAL	2.1	10.2	12.3	2.4	8.5	10.9	15.1	1.1	16.2	2.2	10.3	12.5	2.4	8.6	11.0	15.1	1.1	16.2

JUNE

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	1.9	1.9	5.2	.3	5.5	1.3	4.4	5.7	0.0	1.9	1.9	5.2	.3	5.5
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.7	5.2	0.0	2.1	2.1	6.3	.1	6.4	.5	4.7	5.2	0.0	2.1	2.1	6.3	.1	6.4
8	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0
TOTAL	2.2	10.4	12.6	2.4	8.6	11.0	15.1	1.1	16.2	2.2	10.3	12.5	2.4	8.6	11.0	15.1	1.1	16.2

JULY

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	1.9	1.9	5.3	.3	5.6	1.3	4.4	5.7	0.0	2.0	2.0	5.3	.3	5.6
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.6	5.1	0.0	2.1	2.1	6.3	.1	6.4	.5	4.7	5.2	0.0	2.1	2.1	6.3	.1	6.4
8	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0

AUGUST

	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	2.0	2.0	5.3	.3	5.6	1.3	4.4	5.7	0.0	2.0	2.0	5.3	.3	5.6
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.7	5.2	0.0	2.1	2.1	6.3	.1	6.4	.5	4.7	5.2	0.0	2.1	2.1	6.3	.1	6.4
8	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1# LOCKING TIME NORM

ACTUAL TRANSITS
CONTINUED

SEPTEM

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	1.9	1.9	5.2	.3	5.5
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.6	5.1	0.0	2.1	2.1	6.2	.1	6.3
8	0.0	0.0	0.0	0.0	1.6	1.6	1.5	0.0	1.5
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0
TOTAL	2.2	10.3	12.5	2.4	8.6	11.0	15.1	1.1	16.2

OCTOBER

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	1.9	1.9	5.2	.3	5.5
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.6	5.1	0.0	2.1	2.1	6.2	.1	6.3
8	0.0	0.0	0.0	0.0	1.6	1.6	1.5	0.0	1.5
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0
TOTAL	2.2	10.3	12.5	2.4	8.6	11.0	15.1	1.1	16.2

NOVEMBER

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.6	.6	1.2
5	1.3	4.4	5.7	0.0	1.9	1.9	5.3	.3	5.6
6	.4	1.3	1.7	0.0	.6	.6	1.6	.1	1.7
7	.5	4.6	5.1	0.0	2.1	2.1	6.3	.1	6.4
8	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	1.6
9	0.0	0.0	0.0	.2	.2	.4	0.0	0.0	0.0
10	0.0	0.0	0.0	2.2	2.2	4.4	0.0	0.0	0.0
TOTAL	2.2	10.3	12.5	2.4	8.6	11.0	15.4	1.1	16.5

1 DECEM

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.2	.2	.4
5	.4	1.4	1.8	.1	.7	.8	.7	.1	.8
6	.1	.4	.5	0.0	.2	.2	.2	0.0	.2
7	.1	1.4	1.5	0.0	.7	.7	.8	0.0	.8
8	0.0	0.0	0.0	0.0	.5	.5	.2	0.0	.2
9	0.0	0.0	0.0	0.0	.1	.1	0.0	0.0	0.0
10	0.0	0.0	0.0	.3	.7	1.0	0.0	0.0	0.0
TOTAL	.6	3.2	3.8	.4	2.9	3.3	2.1	.3	2.4

2 DECEM

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	.1	.1	.2
5	.2	.9	1.1	.1	.5	.6	.2	.1	.3
6	.1	.3	.4	0.0	.1	.1	.1	0.0	.1
7	.1	1.0	1.1	0.0	.5	.5	.3	0.0	.3
8	0.0	0.0	0.0	0.0	.4	.4	.1	0.0	.1
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	.1	.5	.6	0.0	0.0	0.0
TOTAL	.4	2.2	2.6	.2	2.0	2.2	.8	.2	1.0

JANUARY

	MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 11 LOCKING TIME NORM

ACTUAL TRANSITS
CONTINUED

	FEBRUARY									MARCH								
	MACARTHUR			POE			SABIN AND DAVIS			MACARTHUR			POE			SABIN AND DAVIS		
CLASS	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL	UP	DN	TOTAL
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

GL/SLS LOCK CAPACITY MODEL
SOO LOCK SYSTEM
1985
SEASON EXTENSION 1; LOCKING TIME NORM

QUEUING INFORMATION

MACARTHUR LOCK

	1 APRIL		2 APRIL		MAY		JUNE		JULY		AUGUST		SEPTEM	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	356		356		735		714		741		744		714	
LOCK CYCLE TIME (MIN): MEAN	78	85	82	79	110	88	110	88	110	88	110	88	110	88
: ST DEV	10	8	10	7	10	7	10	7	10	7	10	7	10	7
AVE.WAITING TIME (HOURS)	.05	.08	.04	.21	.19	1.25	.19	1.25	.19	1.25	.19	1.25	.19	1.25
MONTHLY WAITING TIME (HRS)	0	2	1	13	12	396	13	387	13	400	13	403	13	387
AVE. QUEUE LENGTH (SHIPS)	.00	.01	.00	.04	.02	.54	.02	.54	.02	.54	.02	.54	.02	.54
LOCK UTILIZATION (%)	10		24		63		63		63		63		63	

	OCTOBER		NOVEMBER		1 DECEM		2 DECEM		JANUARY		FEBRUARY		MARCH	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	738		717		360		384		0		0		0	
LOCK CYCLE TIME (MIN): MEAN	110	88	110	88	77	78	77	81	0	0	0	0	0	0
: ST DEV	10	7	10	7	10	7	10	8	0	0	0	0	0	0
AVE.WAITING TIME (HOURS)	.19	1.25	.19	1.25	.02	.14	.01	.10	0.00	0.00	0.00	0.00	0.00	0.00
MONTHLY WAITING TIME (HRS)	13	400	13	387	0	7	0	3	0	0	0	0	0	0
AVE. QUEUE LENGTH (SHIPS)	.02	.54	.02	.54	.00	.02	.00	.01	0.00	0.00	0.00	0.00	0.00	0.00
LOCK UTILIZATION (%)	63		63		17		13		0		0		0	

YEARLY WAITING TIME (HOURS) UPBOUND: 90. DOWNBOUND: 2784.

POE LOCK

	1 APRIL		2 APRIL		MAY		JUNE		JULY		AUGUST		SEPTEM	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	356		356		735		714		741		744		714	
LOCK CYCLE TIME (MIN): MEAN	88	97	107	92	141	105	141	105	141	105	141	105	141	105
: ST DEV	14	15	10	14	13	15	13	15	13	15	13	15	13	15
AVE.WAITING TIME (HOURS)	.08	.09	.09	.24	.38	1.52	.38	1.52	.38	1.52	.38	1.52	.38	1.52
MONTHLY WAITING TIME (HRS)	1	2	2	13	28	401	27	392	28	406	28	410	27	392
AVE. QUEUE LENGTH (SHIPS)	.01	.01	.00	.04	.04	.55	.04	.55	.04	.55	.04	.55	.04	.55
LOCK UTILIZATION (%)	10		24		63		63		63		63		63	

	OCTOBER		NOVEMBER		1 DECEM		2 DECEM		JANUARY		FEBRUARY		MARCH	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	738		717		360		384		0		0		0	
LOCK CYCLE TIME (MIN): MEAN	141	105	141	105	96	87	91	90	0	0	0	0	0	0
: ST DEV	13	15	13	15	14	14	15	15	0	0	0	0	0	0
AVE.WAITING TIME (HOURS)	.38	1.52	.38	1.52	.03	.16	.02	.11	0.00	0.00	0.00	0.00	0.00	0.00
MONTHLY WAITING TIME (HRS)	28	406	27	392	0	7	0	3	0	0	0	0	0	0
AVE. QUEUE LENGTH (SHIPS)	.04	.55	.04	.55	.00	.02	.00	.01	0.00	0.00	0.00	0.00	0.00	0.00
LOCK UTILIZATION (%)	63		63		17		13		0		0		0	

YEARLY WAITING TIME (HOURS) UPBOUND: 196. DOWNBOUND: 2824.

SABIN AND DAVIS LOCKS

	1 APRIL		2 APRIL		MAY		JUNE		JULY		AUGUST		SEPTEM	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	356		356		735		714		741		744		714	
LOCK CYCLE TIME (MIN): MEAN	45	49	44	51	45	61	45	61	45	61	45	61	45	61
: ST DEV	5	4	4	4	4	4	4	4	4	4	4	4	4	4
AVE.WAITING TIME (HOURS)	.07	.00	.11	.01	.35	.02	.35	.02	.35	.02	.35	.02	.35	.02
MONTHLY WAITING TIME (HRS)	4	0	13	0	163	1	158	1	166	1	166	1	158	1
AVE. QUEUE LENGTH (SHIPS)	.01	.00	.04	.00	.22	.00	.22	.00	.22	.00	.22	.00	.22	.00
LOCK UTILIZATION (%)	15		23		48		48		48		48		48	

	OCTOBER		NOVEMBER		1 DECEM		2 DECEM		JANUARY		FEBRUARY		MARCH	
	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN	UP	DN
LOCK OPERATION TIME (HRS)	738		717		360		384		0		0		0	
LOCK CYCLE TIME (MIN): MEAN	45	61	45	61	43	43	45	44	0	0	0	0	0	0
: ST DEV	4	4	4	4	4	4	5	4	0	0	0	0	0	0
AVE.WAITING TIME (HOURS)	.35	.02	.35	.02	.02	.00	.01	.00	0.00	0.00	0.00	0.00	0.00	0.00
MONTHLY WAITING TIME (HRS)	163	1	161	1	1	0	0	0	0	0	0	0	0	0
AVE. QUEUE LENGTH (SHIPS)	.22	.00	.22	.00	.00	.00	.00	.00	0.00	0.00	0.00	0.00	0.00	0.00
LOCK UTILIZATION (%)	48		48		6		2		0		0		0	

YEARLY WAITING TIME (HOURS) UPBOUND: 1151. DOWNBOUND: 6.

ACTUAL CARGO FLOW BY COMMODITY AND MONTH

CARGO	1 APR	2 APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	1 DEC	2 DEC	JAN	FEB	MARCH	TOTAL
WHEAT	253	622	3058	2970	3083	3095	2970	3070	2983	479	333	0	0	0	22916
SOY BEAN	1	2	8	8	8	8	8	8	8	1	1	0	0	0	61
BAR+RYE	56	138	678	659	684	687	659	681	662	106	74	0	0	0	5084
CORN	16	38	188	182	189	190	182	189	183	29	20	0	0	0	1406
OIL SEED	14	35	173	168	175	175	168	174	169	27	19	0	0	0	1297
LIMESTN	23	56	275	267	277	278	267	276	268	43	30	0	0	0	2060
IRON ORE	816	1987	9766	9487	9846	9886	9487	9806	9527	1531	1064	0	0	0	73203
COAL	125	305	1499	1456	1511	1517	1456	1505	1462	235	163	0	0	0	11234
RAW MATL	1	4	17	17	17	17	17	17	17	3	2	0	0	0	129
PETROL	14	35	173	169	175	176	169	174	169	27	19	0	0	0	1300
CEMENT	10	26	127	123	128	128	123	127	124	20	14	0	0	0	950
MINERAL	6	15	74	72	74	75	72	74	72	12	8	0	0	0	554
DRY BULK	22	54	267	259	269	270	259	268	260	42	29	0	0	0	1999
GEN CARG	15	37	182	177	184	184	177	183	178	29	20	0	0	0	1366
STL PROD	4	10	50	49	50	51	49	50	49	8	5	0	0	0	375
TOTAL	1376	3364	16535	16063	16670	16737	16063	16602	16131	2592	1801	0	0	0	123934


END
DATE
FILMED
3-82
DTIC